GIANT POWER

Large Scale Electrical Development as a Social Factor

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MORRIS LLEWELLYN COOKE
Director of Giant Power Survey of Pennsylvania

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FOREWORD

LARGE scale electrical development tapping the cheapest sources of power and practicing every economy—such as monster generating stations and by-product recovery where coal is used—with mass transmission at high voltages, if need be to great distances, to the areas of distribution and use and the whole integrated for operation into a single system—that is Giant Power—at least the technical side of it. Such a conception spells a revolutionary break with current practice.

But quite apart from its technical implications Giant Power signifies a social approach to power problems quite distinct from—even if not entirely unaffected by—financial considerations. Giant Power seeks to substitute the look-ahead for regret after the event; to suggest a planned future as contrasted with a drifting policy. Giant Power can make electrical energy more plentiful, cheaper and more widely distributed. If society is to realize adequately on this great opportunity it will be only through a widely entertained understanding of all the factors involved.

As one contribution to such a public understanding this volume is presented.

MORRIS LLEWELLYN COOKE.

INTRODUCTION[1]

By Gifford Pinchot
Governor of the Commonwealth of Pennsylvania

Mechanical energy is the heart of modern civilization. It was the lack of mechanical energy—power—that kept men back so long in their struggle for control over the elements. It was the lack of it in large amounts which so long delayed the coming of the degree of safety and comfort which is now characteristic of human life in America. We owe the present American standard of living mainly to our use of greater quantities of power per inhabitant than any other people on earth.

From the very earliest times until about one hundred years ago the work of the world was done either by human muscle, by animal muscle, by the pressure of the wind, or by the weight of falling water. When the earliest Pharaohs ruled in Egypt, when Homer sang of the siege of Troy, when the first Christmas dawned to bless the earth, when Columbus discovered a new continent, when William Penn taught brotherhood in a new world, when Franklin laid the foundation for modern electrical development, when the Declaration of Independence was signed, men were still using the same four sources of mechanical power, and had never gone beyond them.

This limitation of available power circumscribed human activity and held back human progress to a degree we of today find it difficult to understand. If the ancients of the old world and the fathers of the new, hampered as they were by the lack of power, still did great things, they did them at a cost in time and in sheer toil which we find it hard even to imagine.

The Discovery of Steam

Upon a world so limited came the discovery of the power of steam. Steam altered the whole face of the earth for its inhabitants. By the creation of a new industrial civilization it utterly changed the conditions of human life. For the first time in history goods could be produced in abundance for all mankind. For the first time in history this abundance could be carried cheaply to all mankind. Steam forced the replacement of individual effort and home industry by industrial organization, for the new steam engine was too big, too expensive, and too complicated to be used except by large numbers of workmen under skilled supervision. Out of steam grew the industrial order and the material civilization of the world today.

What the discovery of steam brought with it was nothing less than a revolution. Because its revolutionary character was not foreseen and provided for, the discovery of steam was followed by generations of fighting on the part of capital to keep, on the part of labor and agriculture to secure, a share in the rewards of greater production. That struggle for economic independence and equality of opportunity is far from settled today. It has produced results of enormous value to humanity, but at enormous and unnecessary cost.

[1] Governor Pinchot in his message to the General Assembly of the Commonwealth of Pennsylvania on February 17, 1925, presented so effectively the possibilities of Giant Power and the need for its guidance for the public use that we reprint here, with his permission, part of that message with slight modifications as the Introduction to this volume.—The Editor.

The change from muscle, wind and water to steam as a source of energy was an epochal change. The change from steam to electricity which is now upon us will not be less so. It behooves us, therefore, not to let it break upon us unawares, not to permit generations of needless bitter conflict to follow it, but to think out the problems it will create, and to take measures in advance to avoid the long train of struggle and disturbance which followed the last great change in industrial power.

Steam might well say of electricity, "One mightier than I cometh, the latchet of whose shoes I am not worthy to unloose," for steam was in fact only the herald of electricity. It is not easy to realize, but electrical development has already proceeded so far that the time is plainly in sight when power for almost every use in the home, on the farm, in the factory, in the mine, and in transportation (by rail at least) will be electrically supplied.

GIANT POWER

Giant Power is a plan to bring cheaper and better electric service to all those who have it now, and to bring good and cheap electric service to those who are still without it. It is a plan by which most of the drudgery of human life can be taken from the shoulders of men and women who toil, and replaced by the power of electricity.

To the housewife Giant Power means the comforts not only of electric lighting, but of electric cooking and other aids to housework as well. To the farmer it means not only the safety and convenience of electric light, but electric power for milking, feed-cutting, wood-sawing, and a thousand other tasks on the farm. To the traveling public it means the speed and cleanliness of electric transportation. To the dwellers in industrial cities it means freedom from the smoke nuisance and the ash nuisance. To the consumer it means better service at cheaper rates. To every worker it means a higher standard of living, more leisure, and better pay.

Giant Power means all this, but means it on one condition only. That condition is the effective public regulation of the electric industry, which is enlisting new capital and spreading its wires over the United States at a rate wholly unknown before.

Giant Power in Pennsylvania will be mainly coal made power. In spite of the great water powers of the Rocky Mountain Region and the Pacific Coast, and elsewhere, all of which will be in use, Giant Power in America will be for many generations mainly the product of coal. It will create, as the mine workers of Illinois have already foreseen, a new demand for coal not now required, and through this new demand may easily become the greatest factor in solving the problem of full time for our bituminous coal mines.

GIANT POWER VERSUS SUPERPOWER

Giant Power and superpower are as different as a tame elephant and a wild one. One is the friend and fellow worker of man—the other, at large and uncontrolled, may be a dangerous enemy. The place for the public is on the neck of the elephant, guiding its movements, not on the ground helpless under its knees.

Giant Power seeks the cheapest sources of power, and hence the cheapest rates. It proposes to create, as it were, a great pool of power into which power from all sources will be poured, and out of which power for all uses will be taken. It is the pooling of supply—not the disposal of surplus—and the chief idea behind it is not profit but the public welfare.

Superpower, on the other hand, is the interchange of small quantities of sur-

plus power at the ends of the transmission line of each system. Its principal object is profit for the companies—not benefit for the public—and it is on the way to being realized with a rapidity which it is difficult fully to understand. If we are to have Giant Power instead of superpower the time in which to make sure of it is very short.

The main object of the superpower idea is greater profit to the companies. The main object of the Giant Power idea is greater advantage to the people. Giant Power will assure vastly better service and vastly cheaper rates to the consumer, and through effective public regulation, it will set aside the threat of the most dangerous monopoly ever known.

Public Regulation

The regulation of any public utility is, and must always be, a compromise. The companies naturally object to every provision for the protection of the public that will interfere to any extent with their freedom to secure their own rates and provide their own regulations, or which will make their investments less profitable, or capital less easy to obtain. The public naturally would like the best of service at the minimum of cost, or at no cost at all.

Neither extreme is possible. For the safety and welfare of the people, there must be restrictions. At the same time, these restrictions must be such as to permit the companies to operate their business successfully, to pay a good but reasonable return upon their invested capital, and to secure additional capital as needed for new enterprises or for expansion.

Electric energy for light, heat and power is, like the telephone, a natural monopoly. We cannot with safety regard it as a mere service and therefore free from control as Interstate Commerce when it crosses state boundaries, as some big electric men would have us do. We must deal with it as a commodity, and therefore subject to such regulation. In any case, being a natural monopoly, it cannot be regulated by competition. Therefore it can only be regulated by public control, and that control, to be effective and to endure, must be fair to the companies, to the investors, and to the general public.

Public control over the electric monopoly may be of several different types. It may be exercised by the individual states; it may be exercised by the Federal Government; it may be exercised by a combination of state and nation; or it may be exercised by public ownership.

The Giant Power plan takes no account of public ownership. It proposes to deal with facts as it finds them, and does not even raise the question. It must and does, however, take most careful account of the form of regulation best fitted to cope with the gigantic electric monopoly which is plainly in sight.

Electric Consolidation

There is already advancing with immense rapidity, a consolidation of companies engaged in supplying this universal source of power which has already far transcended state lines, and has in many respects reached national proportions. The situation which this consolidation clearly foretells is like one in which every source of steam power in America should be under the control of a single monster corporation. In the face of such a concentration of capital and power the states and the nation can maintain their industrial freedom and ability to govern themselves only through the medium of effective public regulation.

The time is almost here when electric utility companies will be interconnected all the way from Chicago to the

Gulf, and from the Atlantic Coast to the Great Plains. Already a single dispatcher (controlling not trains but current) gives orders for the disposal of the power of several interconnected electric systems. Leaders of the electric industry do not hesitate to forecast interconnection in the near future over all the United States. Whatever the ostensible legal and financial status may be, when such interconnection comes it will bring with it inevitably not only effective unity of service but also effective unity of financial and operating control.

GIANT POWER AND STATE CONTROL

In considering state control we must remember not only its advantages but its difficulties and defects. It is axiomatic that to be successful and effective the regulating machinery must cover the same ground as the thing it regulates. Regulation of a nation-wide electric combination by a state alone consequently carries with it such inherent difficulties and such disadvantages, from the public point of view, that nothing less than the wholehearted co-operation of the companies and the states can give it even a reasonable prospect of success.

If co-operation is withheld or impossible, then the next and the inevitable appeal is to Federal regulation. If here again the co-operation of the companies toward securing really effective regulation in the public interest should be refused, then the companies themselves may force the people in self-defense to turn to the only remaining possibility, which is public ownership.

I venture to say that if the people of the United States ever turn to the nation-wide public ownership of electric utilities, it will be because the companies have driven them to it. It will be directly and only because the utility companies have so opposed and prevented reasonable and effective regulation by the states and by the nation that the only choice left was between servitude to a gigantic and unendurable monopoly and the ownership and operation of that monopoly by the people.

The struggle to secure the Federal Power Act, which regulates the development of water powers in navigable streams and upon public lands, lasted for fifteen years. The circumstances were then such that this delay caused no important losses either to the electric industry or to the public. Both had the time to fight it out.

Today the circumstances are wholly different. The development of the network of interconnected electric lines is so rapid that a delay of even five years in establishing effective public control will bring the states and the nation face to face with the immediate threat of an overwhelming and almost uncontrollable electric monopoly. Delay in this matter can have but one result, and that is the formation of a unified unregulated power trust covering with its lines and its domination the whole territory of the United States.

No one who studies the electrical developments already achieved and those planned for the immediate future can doubt that a unified electrical monopoly extending into every part of this nation is inevitable in the very near future. The question before us is not whether there shall be such a monopoly. That we cannot prevent. The question is whether we shall regulate it or whether it shall regulate us.

THE ELECTRIC MONOPOLY

It is almost impossible to imagine the force and intimacy with which such a monopoly will touch and affect, for good or evil, the life of every citizen. The time is fully in sight when every household operation from heating and

cooking to sweeping and sewing will be performed by the aid of electrical power; when every article on the average man's breakfast table—every item of his clothing—every piece of his furniture—every tool of his trade—that he himself did not produce, will have been manufactured or transported by electric power; when the home, the farm, and the factory will be electrically lighted, heated and operated; when from morning to night, from the cradle to the grave, electric service will enter at every moment and from every direction into the daily life of every man, woman and child in America.

We complain, and with justice, that the cost of food doubles between the farmer who grows it, and the housewife who buys it. But if the cost of electric current only doubled between the generating station and the householder's meter the present rates would be cut into small pieces. Producers of electric current commonly sell it to large consumers for a fifth or a tenth of the price they charge to the head of a family, and for much less than the small industrial consumer pays. It is the small user, the average consumer, to whom the companies charge their highest rates.

Nothing like this gigantic monopoly has ever appeared in the history of the world. Nothing has ever been imagined before that even remotely approaches it in the thoroughgoing, intimate, unceasing control it may exercise over the daily life of every human being within the web of its wires. It is immeasurably the greatest industrial fact of our time. If uncontrolled, it will be a plague without previous example. If effectively controlled in the public interest it can be made incomparably the greatest material blessing in human history.

In the near future electric energy and its products will be as essential, as ever present, and as pervasive as the air we breath. The unregulated domination of such a necessity of life would give to the holders of it a degree of personal, economic and political power over the average citizen which no free people could suffer and survive.

The very existence, for example, of industries upon which the prosperity of any one state is based might be endangered by discrimination in favor of other states. This is no fanciful illustration, for the industries of Switzerland are suffering now from just such discrimination by Swiss power companies in favor of German, French and Italian manufacturers.

The situation is almost magical in its boundless possibilities for good or evil. On the good side, it is as though a beneficent power were about to shower upon us gifts of unimaginable beauty and worth. On the bad side, it is as though an enchanted evil spider were hastening to spread his web over the whole of the United States and to control and live upon the life of our people.

No such profound change in economic life is possible without profound changes in law and government. It is the part of statesmanship by foresight to make these changes easy, and to take such account of the mistakes of the past that we shall neither pervert the possibilities nor disappoint the legitimate hopes with which we enter the new era of electricity.

THE GREATEST ECONOMIC QUESTION

What the new civilization to which Giant Power is leading will actually become no man can yet foretell. Steam brought about the centralization of industry, a decline in country life, the decay of many small communities, and the weakening of family ties. Giant Power may bring about the decentralization of industry, the restoration of country life, and the upbuilding of the small communities and of the family.

In this hope of the future lies the possibility of new freedom and great spiritual enrichment of individual life.

Men can use steam power only where it is generated. That is why steam has concentrated vast numbers of people in industrial cities. In a steam-driven civilization the worker must go to the power, but in an electrically-driven civilization the power will be delivered to the worker. Steam makes slums. Electricity can replace them with garden cities.

Next to a supply of natural resources sufficient to feed, clothe and shelter our people, this is the greatest of the economic questions which face the human race. I do not raise it. It has raised itself. But having forced itself upon us, there is but one course we can properly pursue: That is to look it squarely in the face, estimate its possibilities for good or evil, and address ourselves like men to the vast problem of adjusting the growing power of electricity to the growing needs of humanity, remembering that in any solution fit to last and capable of lasting the public good must always come first. Giant Power is the best answer to this gigantic problem that has yet been proposed.

This much is certain—that if we control it instead of permitting it to control us, the coming electrical development will form the basis for a civilization safer, happier, freer and fuller of opportunity than any the world has ever known.

Power Development in Great Britain

By Heber Blankenhorn
London Correspondent of *Labor*

BRITAIN is a backward nation, electrically speaking. She has all the resources to go clear to the front in a new power revolution except the "juice." The same coal fields which gave her world leadership during the steam-power revolution, the same railroads (peculiarly ripe for electrification, both on account of their traction and of the industrial areas which they serve), the same factories, the same breed of skilled workers—these Britain has, but of a present rank as follows (a British view):[1]

kw. h. per year per inhabitant

Switzerland	700	Sweden	364
Canada	612	France	147
Norway	493	Britain	139
U. S. A.	472		

Britain is a little farther behind the United States than the United States is behind Canada. In addition, the following is interesting to note:

Average Growth for Past 15 Years

U. S. A.... 25 kw. h. per year per inhabitant
Britain.... 3.78 " " " " "

Since the trouble is not in the earth beneath, nor in the working inhabitants thereof, a glance must be had at the heaven above, where sits the intertwined trinity of financial, industrial and political leaders who customarily claim the credit for making—never for breaking—a nation. This glance reveals rather more ambitious and more significant plans, on a *national* basis, than in most other countries. An intelligent nation in a hole not infrequently produces the most drastic plans for change. The plans, being shoved by those supposed to have power, might jump Britain to the front; being British, nothing will be done rapidly. This is unfortunate in a matter as fast as lightning, namely, the stride of modern power development.

The central fact in the present electrical supply and, since this is Britain, the key to the future development can be found in the following table:

Electrical Units Sold in Great Britain in 1923

By Private Plants	1,579,896,746
By Municipal Plants	2,758,954,180

That is, "two-thirds of the supply of electrical energy is assumed by the local authorities" (municipal governments). England has been, electrically, and will be, unless she reverses herself, a predominantly public ownership country; and England never reverses.

To infer simply that Britain having much municipal electricity should progress rapidly if she should happen to acquire a national government interested in nationalized power would, however, be omitting those concrete industrial facts which are always playing hob with political theory: in this case it would be omitting Giant Power development and the engineer. The interesting question if Britain is to "show the world" anything important is, can Britain's political economists

[1] Figures of D. Heineman, "Electricity in Region of London," read at World Power Conference, Wembley, July, 1924. The more recent Annual Report of the Electricity Commissioners estimates 100 units per head of total population on the basis of *current sold*, and 200 units or upwards per head of total population on the basis of total units consumed (from private plants in addition to current sold).

Garcke's Manual shows the sale for current in Britain for the past four years practically at a standstill.

seize on the scheme of things toward which the engineer is driving the electric industry and plank it down on British basic conditions (namely coal), scrapping all existing arrangements which do not fit?

Britain has had a government led by socialists and power was in the front of their program; but there was no power engineer in or near the government.

The hesitation of the politician to realize that the times we live in belong to the industrial scientist may lose the nation its present position in the world.

So writes a Labor member of Parliament who is also an electrical engineer.[2]

PRESENT PLIGHT

Before setting forth the present electrical facts, as a background to the national power programs, mention must be made of one fact. Britain's past decade has been spent, half in a business of exporting much of her capital, destroying a million of her best workingmen and converting her raw materials into slivers and gases,—all this called war—and the other half in a business of imposing unbusinesslike European conditions and of waiting for support, in the station to which she had been accustomed, derived from nations similarly depreciated, called victorious peace. Neither business has paid, electrically speaking.

Electricity is generated in Great Britain as follows:[3] (year ending March 31, 1924).

Stations Owned by	Units* Generated	Fuel		
		Coal, Tons	Coke Breeze, Tons	Oil Fuel, Tons
Local Authority Undertakers (248 stations)	3,489,580,935	4,134,612	105,261	13,222
Company Undertakers (190 stations)	1,907,280,734	1,988,572	9,163	44,558
Total (Authorized Undertakers only)	5,396,861,669	6,123,184	114,424	57,780
Railway Companies (48 stations)	571,987,098	687,342	6,467	12,666
Tramway Authorities (27 stations)	334,460,562	425,213	1,715	1,934
Non-Statutory Undertakings (28 stations)	378,214,943	168,478	483	759
Grand Total (541 Stations)	6,681,524,272	7,404,217	123,089	73,139

* Inclusive of units generated by means of oil, town's gas, waste heat, water power, etc.

This was an increase of 16.4 per cent over the previous year, in units, and of 11.2 per cent in coal and coke. (Only 0.6 per cent was generated by water power).

Of these 541 stations the Electricity Commissioners observe: 41 per cent generated less than 1,000,000 units each and 73 per cent less than 10,000,000 each.

If the whole had been generated at modern stations with an average consumption of, say, two pounds of coal per unit, 20 per cent of the coal would have been saved and electrical output increased 26 per cent.

Sales by municipal plants increased

[2] George Hardie, M.P., of Glasgow.

[3] Fourth Annual Report of Electricity Commissioners issued August, 1924.

19.1 per cent and by private companies 18.9 per cent.

The commissioners note an overabundance, not only with regard to stations for public lighting, but "with regard to supplies used for manufacturing and industrial purposes consequent upon the existence of a very large number of private generating plants of all sizes."

The following facts will give some basis for comparisons of rates and finance, especially with American conditions, where in the United States "classic rates" may be summarized as 10 cents urban, 15 cents rural per kw. h. for domestic purposes and 1 cent for industrial purposes: in Canada (Ontario Hydro-Electric) domestic 1.4 cents per kw. h. up to 3 cents at 248 miles from generating station, and for power purposes $13.00 to $25.00 per h. p. per year. Costs per kw. h., 2 mills at Niagara stations, 5 mills at largest New England steam plants.

In Britain (the latest figures are of two years ago) [4] the average price charged for current for light, heat and power by the 5 largest municipal and private plants in Central London was 5.05 *d* (10.1 cents) per unit. The largest (quasi-public) plant in Chicago similar average was 5.41 cents. The largest private plant in London, for lighting, charged a sliding scale of 8–6 *d* (16 to 12 cents) per unit: the largest Chicago plant's similar sliding scale was 9 to 3 cents, averaging 6.11 cents (in 1921).

The 32 authorized distributors (16 municipal, 16 private) for the county of London sold 567,000,000 units in 1921 averaging 2.8 *d* (5.6 cents) per unit; in contrast the price of the larger United States companies was 1.1 *d* (2.25 cents).

As to comparative charges of municipal and private power plants there are no analytical and dependable figures. A comparison of "average price per unit sold" made by the Board of Trade shows municipal plants 2.16 *d* (4.32 cents) private companies, 3.07 *d* (6.14 cents) per unit. Comparisons made by Sir Alexander B. W. Kennedy,[5] who had been engineer for both kinds of plants, show no difference in charges.

The report of the Engineering Committee of the London County Council (just after the war; no fundamental changes since) really gives the British plight in a nutshell: in the London area 77 generating stations, 50 networks, two dozen voltages and half a dozen frequencies. The transmission networks were often superimposed with stations powerless to help each other during breakdowns.

The 77 stations consumed from 27,000 B. Th. U. up to 92,000 B. t. u. averaging 38,900 B. t. u. (or 3.7 pounds of coal) to produce 1 kw. h.; American plants, cited by the engineers, averaged 19,533 B. t. u. per kw. h. (or 1.87 pounds of coal).

The total capital expenditure for the metropolitan (inner London) companies on December 31, 1923, was 18,921,286 pounds or 73 pounds per kw. h. of generating machinery or 12 *d* (24 cents) for every kw. h. produced (net).[6] The largest Chicago plant's capital estimated in December, 1922, was $130,000,000 (or 42 pounds per kw. h. of

[4] Cited by Heineman article, given earlier. These and other World Power Conference papers will be published in four volumes this year by Percy Lund, Humphries and Co., 3 Amen Corner, London.

[5] In his paper "Notes on the Future of Electrical Supply" at Wembley Power Conference. "I should be sorry to be dogmatic on any such question," he wrote in reply to a request for a judgment between municipal and private plants.

[6] "In London the financial charges, such as interest, writing down, depreciation, etc., amount to not less than half the receipts from consumers."

generating capacity), an average of 5.8 cents per kw. h. generated.

Such statistics explain the following generalizations, in which most reports of engineers and financial experts in the last half dozen years agree.

Britain has too many plants, of the widest variations of capacity and incapacity, operating in circumscribed areas. Voltages and frequencies vary; legal restrictions and conflicts abound. Ideas of distance transmission have been choked.

"There exist, as a result, exorbitant capital charges on an inordinate capital outlay." In the great industrial areas as well as London, "the capital invested is not wisely exploited."[7] This applies to private as well as to municipal plants.

Electrical development began on the theory of supply for lighting; Britain lagged in the theory of supply for industrial power. This is still a steam-minded country. The next step, namely, diverse domestic use, has so far been left to a very few municipal plants.

British capital was bolder in going after the high dividends of foreign investment than in taking the risks of home industry. The municipalities which stepped into the breach were protected by the evolution of electricity legislation, initiated by Conservative governments, which provided for the recapture of private power companies (after 20 to 40 years) by the public and which made difficult the entry of the companies into the biggest municipal, *i.e.*, industrial areas.

Now the purely *technical* trend of the industry—toward large stations, monopolizing industrial power supply—has caught a Britain of electric principalities and power parishes. The electrical engineer, as in many another country, has not succeeded in giving "a big lead," acceptable either to municipal or private plants. Even in the offices of the Electricity Commission you may ask about Giant Power and learn, "That is an Americanism for something or other, isn't it?" Permanent officials there called the late Labor Government's power program "hot air."

Instead of producing notably cheaper electricity, the power companies have devoted energies to entrenching their existing domains. The London companies, whose date for purchase by the County Council falls in 1931, recently got through the House of Lords bills extending this date to 1971. In the Commons, the Labor party has opposed the bills as developing "a private trust instead of a public service" and as designed to "retard the maximum development in the industry." A long list of private companies' power bills pends in Parliament; one giving hydro rights in Lanarkshire passed over the stormy opposition of Labor party members. "It was entrenching in Scotland the same local private monopolies that obstruct development in England, when what was required was a single big public monopoly."

The four railroad companies which own all the lines have not moved to electrify their roads, though this is a short-haul country.

THE RISE OF THE POWER IDEA

A stock-taking of British power supply was made in 1917–18 with recommendations for after-the-war development. There is no need to go into schemes and speculations earlier than these reports of the Coal Conservation Committee, chiefly of engineering experts, presided over by Lord Haldane. "Increasing the net output per head of the workers employed in industries in

[7] Utilization of plants, *e.g.*, in Britain is about 1,500 of the possible 8,760 hours in a year: in U. S. A., Switzerland and Italy it averages 3,000 hours.—Heineman.

which power can be used," they found, was the nub of Britain's industrial program. The solution was to be found in electric power. "The best cure for low wages is more motive power." On the character of the needed power the experts were emphatic: it would have to be monopolistic on a national scale.

> The historical development of electrical development during the last 30 years has been local in principle and the resulting position will have to be superseded.

The Reports reiterate heavy emphasis on "without delay." A single supreme electric authority (commission, we would call it) was recommended to create super-stations for districts "with the greatest possible variety of electrical requirements and including populous centres of industrial activity"; the plants to be close to fuel and water, with provision for "the erection of coal-by-product recovery plant . . . plant for electro-chemical processes which have not yet been developed in this country."

To create something new: to have drastic powers; that these were the intentions of the reports for the proposed Electricity Authority, is made plain from Haldane's statement:

> It is unfortunately the case that the working out of such a scheme of power distribution is complicated and hampered by the necessity of utilizing existing plant to the best advantage. The Coal Conservation Sub-committee think, however, *it should not be further hampered by the mistaken policy of the past except in so far as justice requires that fair compensation should be paid for existing rights*, and equitable provision made for the *ultimate liquidation of existing financial obligations.*

The experts' final word was of great hopefulness:

> Fortunately, such a policy is practicable in this country to a greater extent than elsewhere on account of the compact nature of our industrial areas and their close proximity to each other.

The recommended Electricity Authority was:

> (1) To stop the extension or multiplication of power stations;
>
> (2) "*To arrange for the handing over, on equitable terms, of the generation, transmission and main distribution systems* in each of the areas in which the country is to be divided, *to a new Electricity Body for that area*";
>
> (3) To standardize frequencies, etc.;
>
> (4) "To settle for each area whether such body should consist of a Parliamentary company [8] working under adequate control as regards limitation of dividends, etc., or one of the other alternatives given in the Appendix C."

So far as this met the chronic problem, it meant a private monopoly, regulated as well as created, by a national commission; other alternatives were relegated to the appendix. As listed there they were:—where private companies were large, they were to gobble up the others; where municipal plants were large or "local feeling is strongly against a purely company scheme" the gobbling might be the other way; or finally "public or joint [9] ownership" but "with company operation."

WHAT DELAY HAS DONE

But this Electricity Commission never grew up enough to develop trouble in the appendix: before it was permitted to be born the House of Lords removed its virility. The compulsory powers and financial resources of the Coalition Government's bill for commission were taken out, the Lords arguing that the whole thing "smacked of nationalization" and that if all electric power were manufactured in a few

[8] A company obtaining its concession direct from Parliament.

[9] Joint, *i.e.*, municipal and private plants consolidated.

super-stations, a very few laborers in those stations could go on strike, etc.

In 1919 Britain was tired, tired even of being scared: a temporary boom was on: Britain was doing well enough; out of indifference and lethargy came only an emasculated Electricity Commission which began slowly to cajole and joggle together a percentage of plants into various "districts" mapped out by it.

In the years 1919 to 1923 nothing political stood in the way of private capital undertaking the big job on its own. The governments overwhelmingly favored private enterprise; the Electricity Commission was criticized for favoring the power companies at the expense of the municipal plants as often as for anything else. Nothing was done: even railway electrification was out of it. Initial costs were described as too big for unaided private capital. Instead the power companies aggressively developed their industrial supply business on the old regional lines. "Since 1922 the capital invested in electrical undertakings has risen by 43 per cent, generating plants by 60 per cent and units produced by 24 per cent." [10] The companies' dividends in the London area which had ranged from 3.83 per cent to 9.76 before the war ran from 8.5 to 15.6 per cent in 1922. The next year saw the companies' day of opportunity ended by the coming of a labor government.

They had produced no demonstration nor even plan either to bid for support from a labor government or to arouse its opposition. They had produced a larger batch than ever before of the old power bills. The Electricity Commission, its powers slightly increased since 1922, moved so far toward setting up one of the real centralized Electricity Authorities originally contemplated as to cause a great legal dispute. This was in the London area, generating about one-fourth of the country's total units; the power companies stated "the constitution of such an authority would be detrimental to the interests of the private companies," and fetched in, instead, bills for extending their tenure 40 years (to 1971) before their plants would become the property of the municipalities. Of the 27 members of the planned London Authority, 21 were to be popularly elected; two representing the power companies and twelve the municipal plants.

The "cheap and abundant power" contemplated by the Coal Commission Report has not been created. The latest (1924) report of the Electricity Commissioners intimates that "failing the early disappearance of the obstacles which have hitherto retarded progress, the whole position will call for review." Of course it is still true, as Lord Haldane put it in 1918:

> On account of the compact nature of the country such a (power) system is commercially practicable and advantageous here to a greater extent than it would be in other countries.

POLITICAL REACTIONS

Under the dispensation of the late Labor Government, a summary of "national programs" ran about as follows:

In behalf of private capital, we may take the statements of the head of one of the largest power companies: [11]

> The conciliation of all interests represented rather than the imposition of legislation has been undoubtedly sound. In a few years Britain should be electrically one of the most highly organized countries in the world. . . . Sometime in the fu-

[10] Figures given by the Chancellor of the Exchequer, July 30, 1924; the figures of course apply to municipal and private plants.

[11] Major-General Sir Philip A. M. Nash, of the Metropolitan-Vickers; article on "The Reorganization of Power Generation and Supply." He failed to answer specific questions as to American criticisms of British super-power ideas.

ture there may be a number of Giant Power stations in this country with an immense network of transmission lines radiating out from them to every capital, to every town, to every factory and mine, but the economic position of the country at present scarcely justifies any hope of such a perfect scheme. Even in the United States where the generation of electric power is more than three times that of Britain on a similar basis, the Giant Power station is still far from realization on the scale imagined by the theorists. . . . The capital cost of the transmission mains . . . constitutes perhaps the main obstacle to the superpower station in Britain conceived according to American ideas.

The sound method is a certain amount of specialization—industrial power to be left to the power companies (with extended franchises) and lighting and domestic exploitation to municipal companies. Not one mention of coal by-products in connection with power plants. As to railway electrification it would be a fit culmination if the power companies get that business.

In short there is little evidence to combat the many statements made in Parliament in debates on power companies' bills that the power companies "want to get and preserve a monopoly while there is time," *but do not create power*. The company "acquired those powers in 1901 and there is not a single cable laid yet and no prospect of it"; so runs a typical criticism; "I can see some foresight in this bill. The nation cannot nationalize this until 1998. That is some foresight."[12]

On behalf of the political organization closest to the same interests Mr. Lloyd George has just promulgated a "Coal and Power" program[13] for the Liberal party. "Of any sign of great power projects such as are being pushed by our foreign rivals there is no trace" in Britain, says this program. It proposes to "place the whole executive management in the hands of private enterprise, save that the Electricity Commissioners are given certain necessary negotiating and over-riding powers as regards existing interests."

Lloyd George paints a dismal picture of Britain with wages and horsepower per worker each less than half those in America.

In essence the problem that confronts us today is how to increase wages, and thus bring about a swifter circulation of money and an increase in the volume of internal trade, without at the same time increasing the cost of manufactured commodities.

Longer working hours is a reactionary policy.

It took 40 years to break down the arguments of the reactionaries in the early 19th century who were demanding not only that men must be overworked but that women and little children should be oppressed with long hours. The argument then was that to have cheap goods we must have cheap labor. That argument was sound but the conclusion was fallacious, the fallacy lying in the assumption that by labor one means the labor of men, women and children.

Cheap labor should mean, to-day, cheap power.

Superpower stations with by-product recovery plants, electrification of railways, creation of benzol, dye and chemical and fertilizer industries—all these are in this power program. The companies will necessarily be monopolies which should be regulated similarly or more stringently than the railways. The steam revolution was "allowed to come about without any intelligent or imaginative direction or regulation: all our main social ills have resulted from this fact." The electrical revolution "can give us a clean in place of a dirty civilization," and can redeem the past by "regulation and control without

[12] T. Johnston, M.P., in Parliament, July 9, 1924.

[13] Published as a book by an unnamed investigating committee, summer 1924.

sacrificing the driving power of private enterprise." As to finance, state aid will be necessary.

This widely disseminated program—it was even sold on news-stands everywhere—met a curious reception. It aroused no discussion, no greeting from the industry, little response from the public. There was a disposition to regard it as politics.

THE LATE GOVERNMENT'S PROGRAM

That that was very little the case with the final program we shall examine; first because it was a government program, announcing money being spent on it; second, because it was immediately recognized as inherently a part of the government party's general philosophy. It was recognized with hostility by power companies; by the Labor party it was widely approved as getting on with their job. In their job, of course, the "nationalization of basic industries" has filled many party conferences, reports and investigations. As late as the Party Conference of October, 1924, with the Prime Minister of Great Britain in the chair, the two leading items, adopted unanimously in a program of five immediate measures, were nationalization of mines and the creation of a nationalized electric power system.

The government program as explained by Chancellor Snowden [14] to Parliament was a tentative enough affair, announcing preliminary expenditures of over 50 million dollars. It involved a three years' scheme for standardizing frequencies; a survey on the utilization of coal, with reference to by-product recovery plants; the engineering surveys [15] for a tidal generation plant (the Severn barrage); the laying of transmission mains by existing concerns, with state subsidies; and a bill for restoring to the Electricity Commission the compulsory powers and financial resources eliminated from the 1919 Act. The tentativeness of the program was evident in its disjointedness and its opportunism; for example, when asked who was to own the transmission mains the government replied:

> If we find it better to work through the big municipalities and (private) companies we shall do it. If we find it better to own them as a state, we shall own them as a state.

But the tendency was unmistakable, despite the government's profession that its concern was solely for a more efficient country, "whether we are an individualist nation, or whether we are a socialist nation." [16]

Under this program the Secretary for Mines has at work "the best brains and most of the expert knowledge of the country" on the problem of coal waste, coal smoke damage, and coal by-product recovery to be developed in connection with electric power. "Electrical development in this country will remain on a fuel-fire basis." A chemical and physical testing of all coal seams is now under way.

The Department of Scientific and Industrial Research under Lord Parmoor has set up the Engineering Committee for the Severn barrage. This scheme, which may be looked on as a detour, or accident, like the existence of Niagara Falls, proposes to utilize the unusually high tidal flow in the River Severn, by barring the river and creating a huge basin (also for shipping) within the bar. Upon the bar itself would be the generating station, operated continuously by the tidal ebb and flow, supplying 500,000 units to be transmitted to as far as London (115 miles) at 120,000 volts. Costs are estimated at $125,000,000. Surveys in

[14] July 30, 1924.

[15] To cost 95,000 pounds.

[16] Statement of T. Shaw, Minister of Labor v. Hansard, July 30, 1924.

1920 left the engineers uncertain as to whether good foundations could be had for the bar.

To make the Electrical Commission the central national electric undertaker was to be the nub of the late government's scheme, with the laying of transmission mains as the (reconstructed) Commission's first creative task. "There is no instance either at home or abroad of any scheme of rural (electrical) development which has been self-supporting," said Mr. Snowden, apparently with special reference to the publicly-owned Ontario Hydro-Electric of Canada, whose rural lines are state subsidized. Besides industrial power the government had its eye on agricultural and domestic development and even envisaged control or subsidy of the electric utensils-supply business. "There might, for instance, be wiring of a house on something like the hire-purchase system." [17] In short, this power program was one of the two domestic national reconstruction schemes [18] to which this first Labor Government really set its hand.

The government tendency was quite unmistakable in the recent Labor Party Conference, where, with Labor Ministers co-operating, the Party Resolutions were adopted for the "nationalization of the mining, coke and by-product industries, including the production of bulk electric power" and insisting on the government taking the earliest opportunity for legislation of "a comprehensive national system, based on public ownership and control and that in the meantime no private electricity bill should receive government sanction." The aim is "electric light and heat for every household, farm and factory." The conference demanded as immediate measures:

(a) Compulsory powers to require the institution in every district of suitable size and population of a Joint Electricity Authority, containing a majority of representatives of public bodies, having a statutory obligation to reorganize the local system on approved lines, and equipped with powers of compulsory acquisition of private undertakings;

(b) The retention in national ownership of the proposed inter-connecting transmission lines;

(c) The provision of the necessary capital for the Joint Electricity Authorities by state loans, or with the assistance of state guarantees so as to reduce to a minimum the charge for interest and sinking fund;

(d) Provision for participation in the administration, by works committees, advisory councils, or representation on administrative boards, of the various grades and sections of those engaged in the service.

The Conference cheered the principal advocate, a Labor Member of Parliament, who as a Mayor [19] had been a pioneer in getting his London municipal plant to popularize electricity in the housewife's service. Of his picture of an electrified England—it dwelt on the workman's early morning cup of tea, electrically heated—the conference chairman said, "I thought we were in Heaven."

Certain things have to be said in criticism of the late government's program: the parts of it actually begun are poorly related; to the huge and vital phase of coal by-product industries it pays little more than lip-service; it provided more money for tinkering with existing plants (frequencies and the like) and set up more machinery for conciliating existing corporations than it put into the creation of the new national monopoly which it foresees. In short it bore little mark of the power engineer, and much of the political budgeteer. It was plainly the program of a minority government.

[17] Snowden's announcement.

[18] The other was the housing program.

[19] Herbert Morrison of Hackney, London.

The Development of Electricity in France

By A. Antoine
Ingénieur des Ponts et Chaussées, Strassbourg

and A. Libault
Ancien Elève de l'Ecole Polytechnique de Paris

AFTER the war France had a double task before her: the reconstruction of the devastated areas and the reorganization of her general industrial methods. A large development of her resources in energy was therefore necessary and far-reaching schemes for the increased use of electricity have been set on foot.

Whereas previously such matters had been left to private initiative, each city possessing a steam or hydro-electric station, and most of the hydro-electric plants having been built up by industrial companies for their own uses, after the war the government realized that it was necessary to co-ordinate individual efforts. The official Departments prepared vast schemes for the utilization of water power to guide the private companies, and to facilitate its more thorough utilization in each region.

With the same end in view steps were taken to standardize distribution. In 1918 the government stressed the advantages accruing from the use of three-phase current, 50 cycles, whereby a vast organization covering the whole country was rendered possible.

Consumption of Current

Actual Conditions

At present France has not a complete electric distribution system. Of 38,000 communes, 10,000 only are connected (only 27 per cent). In 1918, however, only 18 per cent were connected. About six million out of 39,250,000 inhabitants use electricity (15 per cent). The power used per inhabitant is only one-third that used in the United States. Transmission lines have been built only in areas of dense population, especially in the industrial centres; in the north, Moselle, Alsatia and around Paris, Lyons, Marseilles, St. Etienne, Bordeaux and Toulouse. Transmission lines in other parts of the country are not sufficiently developed.

The New Schemes

But new transmission lines are being built all over the country and it is believed that within three years the number of consumers will have been quadrupled.

In order to obtain energy as cheaply as possible, due attention has been paid to the importance of a general scheme of distribution, and the electrification of railways, which increases the load factor, has contributed largely to this end.

Electrification of Railways

In 1912 on the Midi Railway Company 51 kilometres of railway were electrified in D. C. current, 850 volts, and the same company afterwards started a general equipment program in monophase current, 16 cycles.

Shortly after the war the *Conseil supérieur des Travaux Publics* gave its attention to the question with a view to ascertaining the best solution for the whole country. Engineering missions were sent to different countries and especially to the United States, and the *Conseil supérieur* decided to standardize with D. C. current, 1,500 volts for

normal service, 3,000 volts being allowed for special lines. It is anticipated that the first stage will include the electrification of the following steam railroads:

Midi Railway Co.	2,684 kilometres
Railway P. O. Co.	2,120 kilometres
Railway P. L. M. Co.	2,266 kilometres
Total	7,070 kilometres

In addition F. 88 kilometres of new lines are going to be constructed and it is estimated that in twenty years' time the total yearly consumption will be as follows:

Midi	600,000,000 kw. h.
P. O.	560,000,000 kw. h.
P. L. M.	1,100,000,000 kw. h.

The utilization of energy for traction is very satisfactory, as it corresponds to 6,000 hours a year, or nearly 70 per cent load factor.

General Consumption Schemes

In the heavy industries the tendency is to use more and more power, many shops working continuously with three 8-hour shifts. Electro-metallurgy, the development of which has made great strides, is able even to use a non-continuous power.

The distributing companies have specially low charges for night current, and the use of electric geysers and accumulators is becoming more and more popular. In rural districts, propaganda is being carried on to increase the use of electricity. The government pays part of the expense for the construction of transmission lines, and exhibitions are provided to demonstrate the latest appliances for use at home and on the farms.

Particular attention is paid by the distributing companies to the power factor. Many make a charge for wattless current, and there is a consequent tendency amongst consumers to improve their power factor by special electrical devices, such as synchronized motors turning idle.

PRODUCTION

Consumption can only be developed if production suffices to meet demand. Until recently production has always lagged behind demand.

In 1913, the total number of h. p. generated in France was 1,000,000. Of this, 21 per cent was produced in the coal power stations and 79 per cent in the hydro-electric stations. In 1924, the total energy generated rose to 3,620,000 h. p., the percentage of steam stations being 34 and that of hydro-electric stations 66. These figures refer only to energy generated by central stations and do not include the energy produced by blast furnaces, mines, etc., for their own use.

The amount of capital invested is estimated as follows:

In coal-burning stations: 2,300,000,000 fr.

In hydro-electric stations: 2,800,000,000 fr.

It may be of interest to give here some further details as to the licenses for hydro-electric plants.

For each hydro-electric plant, the power of which exceeds 500 kw., a special license is given by the government for a maximum of 75 years. At the end of the license period the plant is returned to the government under special conditions, but may be taken over again by the company for a new term. There are special taxes of which mention may be made of one depending on the number of kw. produced. This is revised every five years and decreases with the number of kw.

If the number of hydro-electric plants built in the last few years has not been very numerous, it is because France was obliged to reconstruct her

devastated areas and there was little free capital and few workmen available. New plants are being erected and more and more will be built as soon as the economical situation completely stabilizes.

As we have said, the principal power production centres are in the industrial centres.

In the neighborhood of Paris, the steam plants have a capacity of more than 800,000 kw. The Gennevilliers plant near Paris has a capacity of 240,000 kw., which will be increased to 320,000; it is the biggest station in the world. The steam plant of the C. P. D. E. Company at Saint-Ouen, which provides Paris with its light and power, will shortly have a capacity of 350,000 kw.

In northern France there are several large steam mouth-of-mine plants.

In eastern France—Moselle and Alsatia—the mouth-of-mine plants are supplemented by hydro-electric current carried from Switzerland in special transmission lines.

The industrial centres of the southeast derive most of their energy from the Alps, in which there are many hydro-electric plants with a total capacity of 450,000 kw.

On the south coast also there are several hydro-electric plants. Reference may be made to the large plant at St. Tulle (75,000 kw.), where a steam station is established near the hydro-electric.

In the centre of France only 65,000 kw. are installed.

In the southwest 135,000 hydro-electric kw. are installed and several large steam plants are in service.

New Schemes

As already stated, a large increase in production will soon be realized. Many steam plants are projected, the very dry year of 1921 having shown that hydro-electric stations may fail in times of drought. Coal burning plants have the special duty of regularizing the plants driven by rivers, the peaks being supplied by high mountain plants with reservoirs. The use of mouth-of-mine stations has been more and more developed, but a big effort will also be made to build up hydro-electric plants.

The following water power capacities are easy to equip:

Southeast region	5,000,000 h. p.
Centre region	1,500,000 h. p.
Southwest region	1,700,000 h. p.
Northeast region (Rhine)	800,000 h. p.

The following works will probably be realized first, the government co-operating with private companies:

Rhône installation (1 plant in construction. Chancy-Pougny)	1,150,000 h. p.
Rhine installation	800,000 h. p.
Dordogne installation (Plant of Chavanon in construction)	150,000 h. p.
Truyère installation (In construction)	75,000 h. p.

Other installations will be effected by private companies acting alone, *i.e.*, Arc, Durance, Isère and Romanche installations.

It is specially interesting to know that whilst the Alps, Pyrenees and Rhine have a glacial run-off the Massif Central rivers have a fluvial run-off and therefore the connection of these different regions will offer many advantages.

A special plant is to be built for the utilization of the tides, near Abervrac'h in Brittany, and it is thought that the results will be favorable. A large reservoir is to be established with a capacity of two million to five million cubic meters, according to the height of tide. To regularize the power, a special river station will be built on the Diouris with a reservoir of 11 million cubic meters, where the surplus energy from the tides will be accumulated.

The total power of the tidal plant will be 5,000 h. p., and that of the regulating plant 3,800 h. p.

DISTRIBUTION

Efforts are being made to render distribution as regular as possible by grouping as many different consumers and producers as possible on the same line. Transmission lines connect the different plants, especially in northern and northeastern France, and a large transmission line was built by the government immediately after the war to send to the devastated areas current from Switzerland. Most of these interconnections are of 70,000 volts, but many will be 120,000.

Near Paris an important underground cable of 60,000 volts has been built. It will soon be completed for a distance of 125 kilometres, transporting 30,000 kw.

In the Pyrenees a long 150,000 volt line has been completed for the Midi Railway Company.

Altogether France has already 8,900 kilometres of high tension lines, of which 3,900 are of 90,000 volts.

But further efforts for integration are to be made:

(1) A vast southeastern network of 150,000 volts transmitting energy from the Pyrenees and south of the Massif Central to the cities of Nîmes, Béziers, Toulouse, Bordeaux.

(2) A central network of 150,000 volts transmitting energy for railway lines and industry.

(3) A southeastern network covering the Alps, Nice and Marseilles and sending energy from the Upper-Rhône to Paris.

(4) A northwestern network joining steam plants in the North to those in Paris.

(5) A northeastern network connecting Lorraine and Alsatia to northern France. From this sector the 220,000 volt lines which will carry energy from the Rhine to Paris will probably start.

Many of these undertakings will be carried out by private companies, if necessary with the assistance of the government. Amongst such companies we must include not only the actual power companies themselves but also the consumers' groups, which are built up by chambers of commerce, municipalities, departments, etc. . . . The latter are becoming more and more numerous.

Electric Power in the German Commonwealth

By Count Hugo Lerchenfeld

Member of the German Reichstag and formerly Minister-President of Bavaria

To conquer is the noblest task of humanity provided that it be directed by intellectual and moral forces. Creation is subjected to man's power of mind and will to a large degree. Wonders have been accomplished since primitive man, as the myth runs, fetched fire from Heaven. But we passed through milleniums before the two fundamental pillars of technical achievement were created, namely, the use of steam-pressure and the utilization of electric energy.

Electric energy is protean in character, adopting always new shapes from the indomitable lightning to the current generated by the friction of metallic plates and made subservient in artificial transmission. Within the last 50 years science joined with technical skill has conquered this power. Almost every year had added some marvellous discovery. There are however two facts of particular importance: One, the possibility of storing, transferring and distributing the electric current; and, second, the development of *natural resources* which have hitherto gone to waste or served purposes of lesser economic importance.

How is electricity generated? By the rotation of the dynamo-engine set into motion by any power, especially steam and water. Where is electricity needed? Everywhere, beginning in the great city and large industrial plant and ending in the simplest farmhouse and the smallest workshop.

While the production and use of electricity is thus a universal affair, Germany as a commonwealth occupies a special position with regard to the second of the above stated facts—*i.e.*, the development of the natural and—speaking from the standpoint of the commonwealth—*national* resources.

Though but scantily provided with native raw material, Germany's industrial progress has been amazingly rapid. It ranks among the first industrial and commercial nations. Her population has almost doubled within three generations. This population had to be given the means of earning a livelihood at home since emigration is forcibly limited and Germany never possessed a colonial empire. Since the war the situation has changed for the worse. The deposits of iron-ore developed since 1871 in Lorraine and coal in the Saar basin and Upper Silesia have been lost, rich agricultural districts especially in the east have passed into other hands, and the colonies have been surrendered.

If Germany wants to keep up her standard as a nation this can only be realized by a most intense method of production, a thorough use of her resources and a careful diminution of waste.

Under the high tension of natural energy during the war, this country, thrown entirely upon its own resources, took up the generation of electricity in modern superpower plants especially to meet the demand of saltpetre needed for manufacturing munitions and this because the blockade had cut off the overseas supplies of nitrogen products. Today the process of fixing atmospheric nitrogen by means of the electric arc serves the most peaceful of all occupations—agriculture.

After the war several enterprises planned long ago were hastened to completion, in spite of revolutionary

disturbances, in order to provide work for the unemployed and to put to immediate practical use monies which otherwise would have decayed in the public treasury during the period of inflation. This scheme was equally acceptable to the socialistic theory of "socialization" and to capitalistic interests.

Germany though beaten in the war and harassed by many adverse factors since, shows a greater advance in the direction of electrical development along modern coal-saving lines than does England,

states the report of an English semi-official inquiry on coal and power (1924). Indeed a large system for providing a cheap electric supply for the entire country and for an economic use of coal has sprung up within a few years. This system is adapted to local conditions varying as to the distribution of water and coal according to the orographic, hydrographic and geological situation.

HARNESSING THE WATER SUPPLY

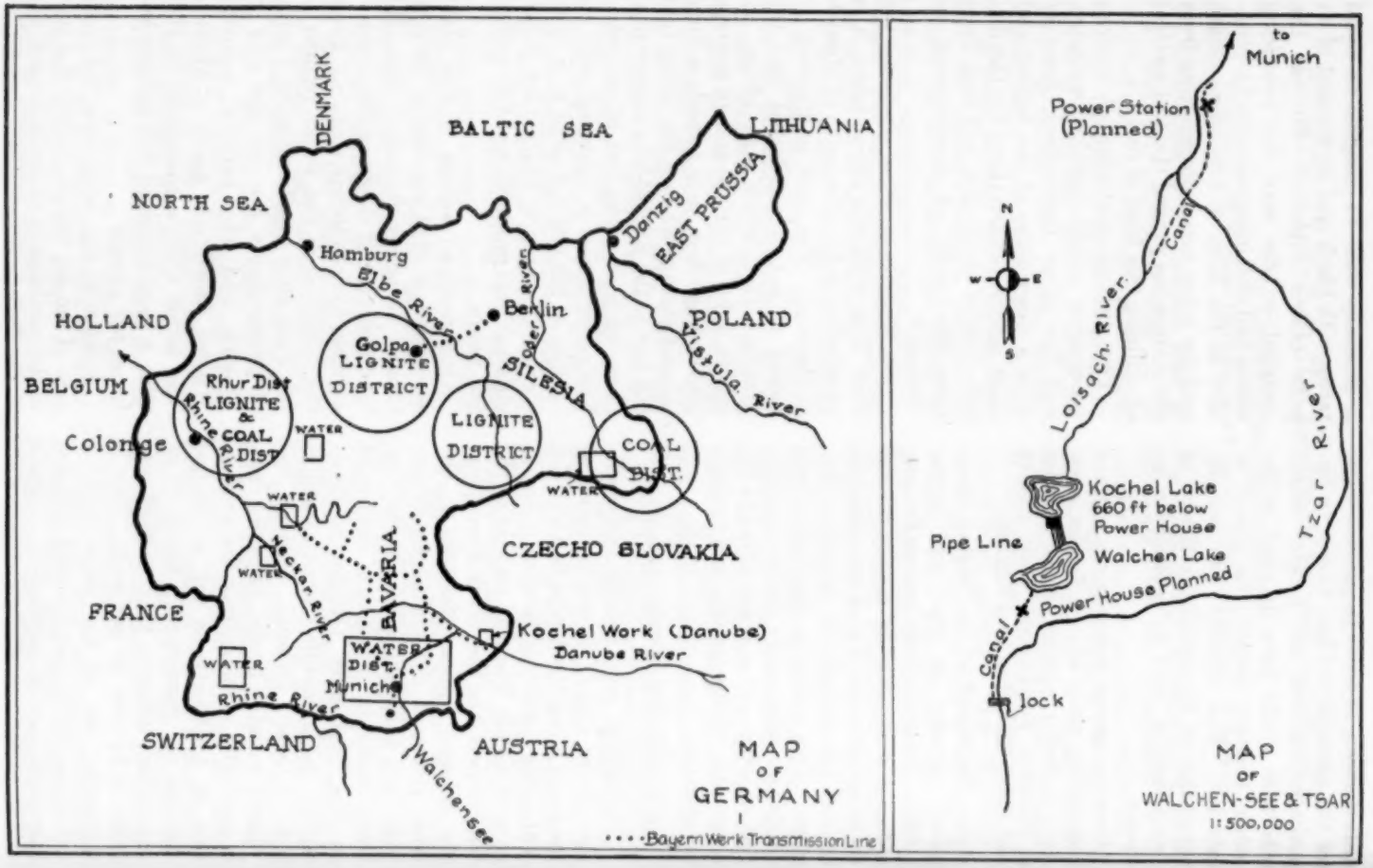
The richest, most reliable and profitable water supply is concentrated at the south along the Alpine belt and lies within the borders of Bavaria. Smaller systems are found in several of the hill districts like the Black Forest and the Silesian range (Sudeten). The great rivers of the northern German plain lack sufficient fall. On the contrary abundant deposits of coal exist in the northwest (Rhineland-Westphalia) in the middle (Saxonia) and in the southeast (Silesia). Among the various varieties lignite, or brown coal, is gradually monopolizing the production of electricity as far as central stations are concerned. Its share of production between 1912 to 1922 rose from 10 to over 40 per cent. This is decidedly one of the most striking examples of how natural and national resources may be developed. Lignite is generally unfit to compete on equal terms with black coal on account of its poor caloric capacity. To use the material on the spot for producing steam and obtaining valuable by-products in the form of briquettes (coke) and the other materials resulting from distillation has proved the best method of utilizing this kind of coal.

Two typical examples of modern superpower plants, one hydro-electric and the other lignite-fired, together with a description of the largest and most modern undertaking for the distribution of electricity, will best illustrate the trend of development in Germany.

The *Walchensee Werk* combines the river Tsar with two alpine lakes; it is situated some 50 miles south of Munich in Bavaria. The river is diverted by means of a lock and canal into the Walchen-lake, which has about six square miles of surface and an average depth of 400 feet, thus forming a huge natural storage whence the water falls 660 feet to the Kochel-lake in huge pipe lines—each of seven feet in diameter. The power-house is equipped with six engines of 128,000 indicated h. p. with a capacity of nearly 125,000 kw. yielding an annual production of 1.60 million kw. hours.

One great advantage of this plant completed in 1924 consists in the continuity of power furnished from the lake reservoir; it deserves the name of an ideal hydro-electric station. From the Kochel-lake the water returns to the Tsar, thus supplying quite a series of power-plants run by the city of Munich and the private company *Misslen Tsar-Werke* north of Munich. The latter will be completed in 1925 with a production of 200 million kw. hours per annum.

Strange to say, ever since the recession of the sea which covered this part of the continent in an archaic epoch and


DENMARK
BALTIC SEA
LITHUANIA
NORTH SEA
Hamburg
Danzig
EAST PRUSSIA
Elbe River
Oder River
Berlin
HOLLAND
POLAND
Golpa
LIGNITE
DISTRICT
SILESIA
Vistula River
BELGIUM
Rhur Dist
LIGNITE
&
COAL
DIST
Rhine River
Cologne
WATER
LIGNITE
DISTRICT
COAL
DIST.
WATER
WATER
Neckar River
CZECHO SLOVAKIA
BAVARIA
FRANCE
WATER
WATER
DIST.
Munich
Kochel Work (Danube)
Danube River
WATER
Rhine River
SWITZERLAND
AUSTRIA
Walchensee
MAP
OF
GERMANY
Bayern Werk Transmission Line
to
Munich
Power Station
(Planned)
N
W
E
S
Canal
Loisach River
Tzar River
Kochel Lake
660 ft below
Power House
Pipe Line
Walchen Lake
Power House Planned
Canal
lock
MAP
OF
WALCHEN-SEE & TSAR
1:500,000

since the glaciers streaming down from the central Alps shaped mountains and plains and dug the lakes and riverbeds, from time immemorial these great currents have hastened on their way to the sea colossal waste!—without being put to further use than the driving of rafts and other small craft. And now, what a change almost overnight! All this had to be accomplished without disfiguring the beauty of this highland country and especially one of its most brilliant gems—the Walchensee. Here complete success was obtained. The great lock on the river fits perfectly into the impressive landscape of the great valley bedded in wooded slopes and overtowered by rocky peaks, while the great system of pipes and the powerhouse lie hidden in the folds of the Kesselberg.

Less romantic is the type of power-station combined with a lignite-pit: the *Golpa-Zshernewitz* plant on the Elbe. Exploitation of lignite deposits differs fundamentally from coal mining. The deposits lie mostly near the surface. To remove, the top is cleared away and the mineral which appears to be of the consistency of garden soil, mixed up with lumps of half-carbonized wood, is worked in an open quarry by means of bucket dredgers and shipped direct to the furnace automatically and almost without human labor at a cost of little over one dollar a ton. In Golpa the seams measure almost 40 feet on an average. The adjoining power-house is furnished with nine steam carbines with a total capacity of 144,000 kw. Together with two additional power stations run on the same principles, the company *Electro-Werke* disposes of a total production of 1,600 million kw. hours a year and provides Berlin by a 100,000 volt transmission live over 100 miles long.[1]

While some 50 years ago it was considered a triumph of technology to carry electric current without considerable loss over a distance of 100 miles, methods are so complete today that high-voltage transmission lines (experiments run as high as 1,000 K. V.) link up practically unlimited areas with superpower stations.

GERMANY'S LARGEST SYSTEM

The largest system in Germany for the time being is the so-called *Bayern-Werk* in Munich, a special company under the government's control and connected with the great hydro-electric enterprises, the Walchensee and the *Misslen Tsar-Werkes*. The *Bayern-Werk* was started in 1920 and inaugurated in 1924. The total length of the 110 K. V. network combined with 12 transforming stations will amount to over 600 miles, the main outline being a circular connection with several outreaching branches. The work has undertaken to provide the greatest part of Bavaria and a few adjoining districts as economically as possible with electric power. Its chief sources are the above-mentioned hydro-electric power-plants and a large plant in construction on the Danube River.

The *Bayern-Werk* has the purpose:

(1) To make full use of the great water powers of Bavaria in order to provide the whole of the country and thus limit the supply of coal which otherwise must be brought from distant parts of Germany or from abroad to Bavaria.

(2) To connect with other electric plants of different systems to supply them with surplus power or to draw

[1] A plan to put a 200,000 voltage-transmission line between the three chief centers of production (Rhino-Westfalian-Middle-German and southern, has been discussed. But some time will elapse before it can be carried out. Further experience must be obtained with the existing 110,000 volt-lines and the necessary capital raised.

from them the power needed to supply all demands made upon the *Bayern-Werk*, under so-called peak agreements.

The *Bayern-Werk* is a wholesale dealer in electricity selling at a price of nearly one cent per kw. h.; it leaves the retail business to its customers, mainly cities and special organizations —the so-called *Überland-Zentralen* (overland-centers). Of course the consumer is charged a much higher price up to tenfold; but the development tends towards a reduction of retail prices.

THE ONWARD MARCH

Technical evolution will never remain at a standstill. The power production problem must go hand in hand with the problem of utilizing electricity. Now modern water turbines are efficient up to 93 per cent of the available power, while steam engines allow of a comparatively small use of the caloric capacity. Oil motors show marked progress in the direction of a more effective utilization of the heat units. Further improvements must be expected on this line and will affect calculations and methods now prevailing. Yet the present principle of developing natural resources is an absolutely sound one from the standpoint of political economy and will always receive proper consideration in spite of all technical and financial conditions.

While in 1913 statistics show 1,000 public electric plants in Germany with a total capacity of 1.5 million kw. and a production of 2,240 million kw. h., in 1922 a slightly reduced number of plants have doubled the capacity and increased the production to 7,230 million kw. h. Formerly, power stations were erected only in the center of the areas of consumption, thus serving only small districts. These small stations so far have not disappeared, but larger stations with a more distant reach are gradually coming into use. There is no doubt that this process will lead to an increasing abandonment of smaller stations in proportion to the better and cheaper service secured by larger stations.

Up to 1922 black coal was used almost exclusively. Since then lignite is gradually taking its place in the production of electricity. Also water power, which in 1922 hardly provided 10 per cent of the production, is much more widely made use of today. The cost and scarcity of coal in the post-war period has hastened these developments. Coal and lignite are more reliable as a rule than water power, which varies according to the season even in the Alps and must be stored in order to secure a reasonably steady supply. On the other hand deposits of mineral are subject to exhaustion within a given period, while the natural resources of rivers remain unchanged. Combinations of systems with peak agreements as well as reasonable central isolation will meet some exigencies of economic life.

GOVERNMENT AND PRIVATE INTEREST

Electricity constituting a universal need, the government must necessarily take a primary interest in this matter. In fact, a large part of the public plants are owned by state communities or local government. As far as the modern superpower stations are concerned socialism has from the beginning demanded monopoly by the state. But the cry for "socialization" of natural resources has not been carried out in spite of the revolution in 1918. New methods are being followed, as, for instance, where the government either co-operates with private capital—an arrangement termed "mixed" enterprise—or when the government provides for private operation while owning the stock. These methods offer

several important advantages. Whereas private ownership and operation under the capitalistic system tend towards a maximum of profits to the managers and shareholders, public interests are naturally apt to be neglected. Cases are rare of what I should perhaps call reformed capitalization, wherein there is some realization of the responsibility of giving the public the best service at the lowest possible price. In "mixed" enterprises this is achieved by means of governmental participation. On the other hand the dangers from political influences and from the lack of good business methods common to bureaucracies are avoided. Capital is not likely to engage in enterprises which after all offer a certain risk and in which the public interest prevails. Quite a number of the largest plants—some have already been mentioned like *Walchensee*, *Misslen Tsar*, *Bayern-Werk*, *Electro-Werke* and the great Rhenish-Westfalian Electric works in Cologne—are organized along these lines as corporations, the stock of which is totally or partly owned by the state.

Private companies of this kind are also developing important projects for inland water transport, such as the Rhine-Main-Danube and the Rhine-Nevkar schemes, both combining canals and navigable rivers with the production of electric power for both financial and economic reasons.

The electrification of railroads has been limited so far to a few local lines of small importance, but a great stride is planned with the completion of the *Walchensee-Werke*, when as a coal saving proposition and owing to the relative cheapness of the power, about 375 miles of main lines in the southern part of Bavaria will be electrified within the next few years. This matter has at least left the purely experimental stage.

There is no doubt that electrification on large scale will considerably alter the economic situation of the country, not only because of superpower plants and great transmission lines but also by reason of grants given to private corporations on mineral deposits and public rivers. To quote a few examples, the *Lenna-Werks* near Halle in Prussia have taken up the manufacture of atmospheric nitrogen on the largest scale in connection with the lignite basin of this district. In southern Bavaria a very important electro-chemical industry has sprung up in connection with some hydro-electric power stations on several rivers by reason of state grants. However, social considerations dictate extreme caution in the industrial development of districts which hitherto were entirely agricultural; the massing of workmen without proper accomodation in such places must be avoided.

On the whole, modern methods of distributing electricity make local industries independent of the power problem. Practically everybody may avail himself of the advantage of modern machinery. Especially the small tradesmen and artisan will be enabled to compete successfully along many different lines with factory production, thus constituting and preserving an element of great social importance.

Also agriculture will profit markedly by this evolution of electricity, which through proper distribution facilities and methods will soon reach the most remote village, where up to the present time grain has been thrashed out by hand.

Human labor is the most valuable article and must be applied where it will yield the greatest profit. Labor-saving machinery as well as new technical methods will result in more efficient work and increased production. About one-third of Germany's population is engaged in farming; Bavaria's share is still larger. These figures prove suffi-

ciently what national interests are at stake.

Post-war Germany sees only one way out of her troubles—steady and economic labor. The power problem ranks among the very first, viewed from any angle. But our justifiable pride in humanity's technical progress must not blind us to the fact that after all this progress is only the means to an end. Technical conquest, admirable as it is, must not blur our vision. Our striving must guide us to the realm of spirituality.

Electrical Development in the Dominion of Canada

By Dr. Frederick A. Gaby
Chief Engineer, Hydro-Electric Power Commission of Ontario

THE noteworthy development in manufacture and in general commerce that has taken place in the Dominion of Canada in, say, the last twenty-five years is largely due to the utilization of this country's extensive water powers. Canada possesses an unusually rich heritage in the water powers of her inland waters. These water powers are widely distributed from coast to coast and are generously available in those districts where native coal supplies are lacking. The widespread distribution of water power is evidenced by the remarkable fact that in Canada over 95 per cent of the total output of central electric stations is derived from water power. Moreover, in the Dominion of Canada, the *per capita* consumption of energy developed from water power now exceeds that of any other country.

In order to obtain a comprehensive understanding of the general lines along which electrical development is progressing in Canada, it is necessary to consider certain factors which are unique for the various provinces of the Dominion, because basic conditions differ radically for different parts of the country. The present discussion, therefore, will—commencing at the Atlantic seaboard—present in brief outline the general water-power possibilities of the various provinces of Canada and the trend of circumstances respectively governing their development.

Prince Edward Island. On account of its small size and the nature of its topography, the province of Prince Edward Island possesses comparatively little water power. Its inland waters, however, are ample for domestic, municipal and agricultural purposes, and will yield about 3,000 horsepower. The General Assembly of Prince Edward Island has passed no special laws applicable to the development and use of water powers. Speaking broadly, the lands of the Island have passed from the possession of the Crown and have carried with them the usual riparian rights as recognized in common law.

Nova Scotia. The province of Nova Scotia has an ample and well-distributed precipitation and on many of its streams exceptional facilities for storage. Although at minimum flow the power possibilities of its streams total less than 25,000 horsepower, it is estimated that an installation of 300,000 horsepower will be justified by the complete development of the available storage. The developments already made have nearly 50,000 horsepower of machinery installed.

Although, in Nova Scotia, the lands have practically all passed from the possession of the Crown and have carried with them the rights to the use of the inland waters including the development of water power, nevertheless, the government of the province, in 1919, took definite action and enacted that

> Notwithstanding any law of Nova Scotia, whether statutory or otherwise, or any grant, deed or transfer heretofore made, whether by the Crown or otherwise, or any possession, occupation, use or obstruction of any water course, or any use of any water by any person for any time whatever, every water course and the sole and exclusive

right to use, divert and appropriate any and all water at any time in any water course, is declared to be vested forever in the Crown in the right of the province of Nova Scotia.

Subsequently, the Nova Scotia Power Act was passed providing for the creation of a Power Commission empowered to

generate, accumulate, transmit, distribute, supply and utilize electrical energy and power in any part of the province of Nova Scotia, and do everything incidental thereto or deemed by the commission necessary or expedient therefor.

This Commission initiated a program of power development and distribution along the lines of public ownership and has already invested about $2,500,000. Power is being supplied under publicly-owned auspices to Halifax, Lunenberg and other parts of the province.

New Brunswick. In the province of New Brunswick there is—assuming full development of the possible storage—an estimated water-power potentiality of over 200,000 horsepower with developments already made totalling about 40,000 horsepower. Several powers of special economic importance are situated along the coast. The largest individual power site is situated in the interior of the province at Grand Falls on the St. John River, and has a potentiality with storage of about 60,000 horsepower. This is the largest water power in the Maritime Provinces. In New Brunswick, as in the case of Nova Scotia, the larger proportion of the water-power sites early passed from the Crown with the grants of the riparian lands.

The province for many years has had rather comprehensive legislation applicable to its inland waters for the protection of timbering and other needs, but not specifically with respect to water-power development. A special statute granted the rights for the development of the Grand Falls water power to private interests, but subsequently provision was made whereby this and other power sites may be developed under a policy of public ownership and operation.

In 1920, the Provincial Legislature passed the New Brunswick Water Power Act which, along with its amendments, provides for a Water Power Commission empowered to function along the general lines laid down for the Hydro-Electric Power Commission of Ontario and which are further explained below. The New Brunswick Commission has already expended over $3,000,000.

Quebec. The province of Quebec possesses water powers which, according to present estimates, will yield a larger total power than is found in any other province. The provincial authorities have encouraged active development of water power, a policy that has resulted in a remarkable growth of manufacturing centers like Chicoutimi, Drummondville, Grand Mère, Shawinigan, Sherbrooke, Three Rivers and other places. Practically all important municipalities are supplied with hydro-electric power and light, and power is extensively used in pulp, paper and timber mills, as well as in mining and electro-metallurgical activities. The water-power possibilities of the province have been placed at about 7,000,000 horsepower under conditions of minimum flow, but this figure would be considerably increased by the fuller development of the available storage facilities. The installed capacity of developments at present in operation is about 1,200,000 horsepower. The chief water-power stream at present developed in the province of Quebec is the St. Maurice River, where developments aggregating about 550,000 horsepower of installed capacity have been made and additional sites with an

aggregate potentiality of about 500,000 horsepower are available. The largest undeveloped water-power sites are on the St. Lawrence River where an aggregate capacity of over 2,000,000 horsepower is available, in addition to developments already made aggregating 250,000 horsepower. An important development is now being made on the Saguenay River where over 500,000 horsepower may ultimately be secured. Elsewhere in the province there are installed about sixty plants of between 1,000 and 30,000 horsepower each.

The Quebec authorities exercise a paramount jurisdiction over the provincial water powers, and in general the policy has been to lease the water powers for development by private enterprise on a rental basis. The provincial water powers are administered by the Minister of Lands and Forests. The right to use these water powers is generally granted in the form of an emphyteutic lease. The leases are usually disposed of by tender, or by public auction. The usual period for the lease is seventy-five years, and the royalty is a fixed amount per horsepower developed and is subject to revision usually every ten years.

The province itself, by its policy of developing the exceptional storage possibilities of its rivers, has contributed substantially to the general success attained, and has constructed large engineering works for the storage of flood waters, thereby supplementing and regulating stream flow. These storage works, as well as general investigations in connection with the provincial water powers, are under the direct supervision of the Quebec Streams Commission, established by provincial authority in 1911. This Commission built the Gouin Dam, which provides a reservoir covering an area of 300 square miles with a storage capacity of 160,000,000,000 cubic feet,—the second largest artificial reservoir in the world, being surpassed only by the Gatun Lake on the Panama Canal. The Commission also spent $2,500,000 in acquiring storage dams on the Manouane River. Storage programs are being carried out also on the St. Francis and St. Anne de Beaupre rivers, as well as on Lake Kenogami and the river Metis. The Commission has spent on completed works about $3,500,000, on which it is receiving a revenue of about $300,000. The annual cost of these storage works is apportioned among the various developments benefiting therefrom.

Ontario. The province of Ontario is also exceptionally well endowed with water power, and both the government and the people of Ontario are well alive to the economic value of these powers. Like her sister province, Quebec, Ontario has many large power undertakings—similar to those just enumerated for Quebec—developing power for use in pulp and paper, electro-chemical and other manufacturing industries. Powers like those on the Ottawa River, on the Nipigon River and many others which might be specially mentioned, are all within the field of usability and are of very great economic importance. Many sites have already been developed. On the Niagara River, in Canada, developments already made or under construction have a rated capacity of about 750,000 horsepower.

The province of Ontario has a half interest in the water power in the international stretch of the St. Lawrence River which extends about 110 miles down the river from Lake Ontario. In the stretch of river from Prescott to Cornwall, a distance of nearly 60 miles, there is a fall of 90 feet, and at two main sites in this portion of the river, there is a possibility of developing over 1,800,000 horsepower, of which 900,000 peak horsepower would

belong to Ontario. For several years the Hydro-Electric Power Commission of Ontario has been conducting special surveys and investigation along the St. Lawrence River in order to determine the best means of developing the international reach of the river in the joint interests of power and of navigation. There are two important natural power sites in this portion of the St. Lawrence, one in the vicinity of Morrisburg, Ontario, and the other at the Long Sault rapids near Cornwall, Ontario. It is hoped that the upper power site at Morrisburg will, at an early date, be developed in the interests of the citizens of the Dominion of Canada and of the United States.

It is problematical to what extent many of the large water powers of the province of Ontario may be increased by the utilization of storage, but it is certain that under conditions of actual development, many water powers will greatly exceed in magnitude the preliminary estimate. The water powers of the province of Ontario—according to present estimates—may be placed at about 6,000,000 horsepower with approximately 1,500,000 horsepower developed.

Manitoba. The province of Manitoba, although one of the Prairie Provinces, has, nevertheless, a great water-power heritage. The Winnipeg River has a potentiality of about 265,000 horsepower which, by storage, may be increased to about 450,000 horsepower, and of this some 160,000 horsepower has been developed,—this represents practically all the water power developed in the province. The Winnipeg River powers are within economic transmission distance of, and supply, the city of Winnipeg and other municipalities. In the more northerly portion of the province is the Nelson River with a drainage basin of 450,000 square miles. By developing the utilizable portion of its fall of over 700 feet between Lake Winnipeg and Hudson Bay, it is estimated that this river would yield possibly 2,500,000 horsepower. It is, in fact, the only other river in Canada comparable in magnitude of water-power possibilities to the Niagara and the St. Lawrence. The estimated low-water power of Manitoba may be placed at about 3,500,000 horsepower.

The jurisdiction over the water powers in the province of Manitoba, as is also the case in the provinces of Saskatchewan and Alberta, is vested in the federal government of Canada. The Dominion authorities grant no subsidies or tax exemptions in connection with the water powers which they administer, but municipalities, in some instances, grant special assistance to industries in the form of a grant of free sites, exemption from certain taxation, or a fixed assessment for a term of years. The water powers on public lands administered by the Dominion are with some exceptions under the administration of the Minister of the Department of the Interior. In this work, the Minister has the assistance and advice of the officers of the Dominion Water Power Branch,—a branch of his department. The administrative policy is based upon the Dominion Water Power Act which, although prohibiting any sale outright of water powers, nevertheless provides liberal terms upon which license may be granted for development. The Act gives wide powers to the executive. Many important developments of water-power rights granted by the federal authorities have already been undertaken by both municipal and private enterprise. Provision is made whereby the Dominion authorities may, in the general public interest, acquire power sites already developed for use as governmentally-owned and operated enterprises. The

water powers on the canals of Canada are under the control of the federal Minister of Railways and Canals.

Saskatchewan. Being essentially a Prairie Province, Saskatchewan, relatively speaking, has small water-power possibilities. In the southerly portion of the province, the Saskatchewan River has a low-water potentiality of about 60,000 horsepower with about three times this amount for the open-water season. In the northern part of the province better facilities exist for storage. The total low-water power for the province may be placed at over 400,000 horsepower with from two to three times this quantity during the open season. Practically none of this power has been developed.

As already mentioned, the administration of the Saskatchewan water powers is under the Department of the Interior and accords with the general procedure described for the province of Manitoba.

Alberta. Much of the area of the province of Alberta is prairie country. In the southern portion east of the Rocky Mountains, the annual precipitation is small and the use of streams for power would be subservient to their requirement for irrigation—a pursuit extensively practised. Power sites on the Bow River and its tributaries in southern Alberta aggregate about 50,000 horsepower, which amount may be more than doubled by the utilization of storage. To the north, the Athabaska River and tributaries have water powers estimated at about 100,000 horsepower, and at Fort Smith Rapid on the Slave River some 250,000 horsepower is available. These estimates are for low-water flow and in an average winter. During the open-water season, probably about three times this amount of power is available. The total estimated low-water horsepower for the streams of Alberta is 450,000, corresponding during the open season to about 1,200,000 horsepower. The installed capacity at the developments already made is about 33,000 horsepower. With its rich coal deposits, Alberta is remarkably well circumstanced to develop low-cost steam power.

What has previously been stated with regard to the jurisdiction of the Department of the Interior over the water powers of Manitoba and Saskatchewan applies also to Alberta.

British Columbia. With its exceptional physical features such as mountains, heavy precipitation, melting glaciers and snowfields, storage possibilities and high heads, the province of British Columbia possesses many valuable, well-distributed water powers.

The total water horsepower available to the province has been variously estimated at from two to three million for low-water conditions with such storage as had already been developed or determined to be available for certain sites specially investigated. But this figure by no means adequately represents the power potentialities of British Columbia. Many streams have been examined only by reconnaissance methods, and the power possibilities of a large number of smaller streams are as yet unknown. It may be stated, therefore, that allowance for the utilization of extensive storage in connection with the development of power sites that have been insufficiently investigated and other factors will, in the future, warrant the presenting of a total water-power potentiality for the province of British Columbia very substantially in excess of the tentative figure above presented.

Within a 50-mile radius of the city of Nelson there are power sites, chiefly on the Kootenay and Pend-d'Orielle rivers, having an aggregate potentiality of

400,000 horsepower. Again, within 50 miles of the city of Vancouver there are water powers aggregating some 300,000 horsepower. Along the coastal region there is estimated to be available over 1,000,000 horsepower.*

The province of British Columbia has jealously preserved its water rights and has demanded that these, when transferred to others, be *beneficially* used. From the early days of gold mining with its exacting demands upon water for sluicing and other mining purposes, the government of British Columbia has been careful to enact water legislation so as to reserve unusually full jurisdiction over the use of the inland waters of the province. Later, when power development came into greater prominence, existing legislation was implemented so that it may be stated that the present Water Act of British Columbia is the most comprehensive code of water legislation in the Dominion. At the same time, the province facilitates the granting of irrigation, water-power and other rights to *bona fide* users.

An examination of the water-power developments already operating in British Columbia shows that they are of a high order, whether for municipal supply or for general commercial and industrial purposes. The chief developments are in the vicinities of the cities of Vancouver and Victoria, supplying electricity for the power, light and railway requirements of these communities. These developments are: for Vancouver and vicinity, the Coquitlam-Buntzen developments on Burrard inlet with a combined capacity of 85,000 horsepower, and the Stave Lake development with a capacity of 54,000 horsepower; for Victoria, the Jordan River development, 40 miles from Victoria, with a capacity of 24,400 horsepower, and a smaller development at Goldstream near the city with a capacity of 4,100 horsepower. In the interior important developments on the Kootenay River in the vicinity of Nelson with a combined capacity of 57,000 horsepower, supply power to a number of mining and agricultural communities. On the coast many important developments have been made in connection with the pulp and paper industry, and also in connection with mining, including coal mining.

WHAT HAS BEEN DONE

From the foregoing brief survey, it has been noted that the older provinces of Canada, even though in the past they have parted with many rights appurtenant to their inland waters, nevertheless, have later sought in various ways to initiate programs by which the waters, and especially the water powers, could be developed and utilized as directly as possible in the general public welfare. It has also been noted that in some instances the means employed have been more markedly along the lines of development through private enterprise, while in other cases the development has been essentially along the lines of public ownership and of municipal co-operation. The Canadian national power program, as a whole, can only be comprehended by an understanding of the power programs of the individual provinces. These have now been reviewed and it becomes evident that the present trend promises that future development will be along the general lines laid down by the various provinces, as briefly outlined in the foregoing statement.

Canada has been a pioneer in the advancement of the art of developing electrical energy from water power and in solving the problems connected with its long-distance transmission and widespread distribution. In the more populous districts of Canada, notedly in southern Ontario, and in portions of

Quebec, the power movement has been, and is, along the lines sometimes described by the popular terms "giant" or "super" power, and in this class the Canadian achievement is of a very high order.

An outstanding example of this class of movement in Canada, and one conducted along unique lines, is the hydro-electrical undertaking of the municipalities of the province of Ontario;—an undertaking owned, controlled and operated by over three hundred and eighty municipalities that have co-operated to supply their citizens with electricity at cost, through the agency of what is known as the Hydro-Electric Power Commission of Ontario.

THE WORK OF THE HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO

About the year 1900 the suggestion that a supply of electrical energy might be secured from the Niagara River for the power needs of southern Ontario took definite form for public consideration. The great interest taken in this suggestion was primarily due to the absence of coal resources in the province of Ontario and, later, was stimulated by public meetings and by discussions in the press. It was, however, not until 1906, following the report of a special investigating commission, that the Legislature of the province, by special act, provided for the creation of the Hydro-Electric Power Commission of Ontario —the organization now in existence. This Commission acts as trustee for co-operating municipalities.

By the end of 1910 the Commission had initiated its municipal program by distributing, over its own transmission lines, power purchased by public tender from an existing company having an extensive plant already operating at Niagara Falls. The small initial load of less than 1,000 horsepower increased rapidly until in 1914 it was 77,000 horsepower, and by 1915 the Commission reached the limit of its contract with the Ontario Power Company for 100,000 horsepower. The Commission arranged for an additional power supply from the Canadian Niagara Power Company of 50,000 horsepower, and from the Toronto Power Company of over 25,000 horsepower. Subsequently, in August, 1917, it purchased outright the Ontario Power Company with its plant capacity of 160,000 horsepower, which was increased to 180,000 horsepower in 1919; and, in December, 1920, acquired the Toronto Power Company with its plant of over 125,000 horsepower capacity. In 1920 the load was 356,000 horsepower. The Commission, recognizing the rapidly increasing demand for electricity, decided, in 1917, to proceed with the construction of a large, new plant at Niagara. This is the Queenston-Chippawa development, and is designed to provide for an ultimate development of over 600,000 horsepower. Today, the Hydro-Electric Power Commission is distributing about 750,000 to 800,000 horsepower. The Commission operates water-power installations which, when fully developed, will have a potentiality of over 1,000,000 horsepower.

The transmission lines of the Hydro-Electric Power Commission total about 4,000 miles in length, including over 520 miles of 110,000-volt lines. The greatest length of continuous 110,000-volt line is that between Niagara Falls and Windsor, a distance of approximately 250 miles. The transmission lines of several of the systems obtaining their basic supply of power from different water-power developments are already interconnected, making interchange of power possible and increasing the reliability and economy of the combined systems; and the time is probably not far distant when the transmission lines of the whole of southerly Ontario

will be connected up into one vast transmission system. In addition to the Commission's main overhead lines, there are, of course, the distributing lines of the various municipalities, totalling hundreds of miles in length. Distribution lines have also been extended into the rural districts and many villages, hamlets, and individual farmers are receiving the benefits of low-cost "hydro" power.

FINANCIAL STRUCTURE

Space does not permit a further elaboration of this publicly-owned, municipal undertaking; but it may be further studied—if so desired—through the Commission's annual reports and other publications. In conclusion, however, it may be added that certain principles, which the inaugurators of the "hydro" undertaking believed sound, were laid as a basis upon which to administer the various assets in which the municipalities are concerned. The general system of administration adopted may briefly be described as follows:

First: The generation and transmission of power on a wholesale scale is dealt with by a Commission which, although appointed by the government of the province, acts independently in the capacity of trustee for the partnership of municipalities.

Second: The local distribution of electrical energy within the borders of each municipality is, in general, under the administration of a public utilities commission appointed under the provision of the Public Utilities Act.

Third: Capital required for the plant for the generation and transmission of power is loaned by the government upon receipt of formal requisition from the Commission. Contracts are entered into between the Commission and the municipalities under the terms of which the municipalities undertake to repay over a period of thirty years the monies thus loaned by the government with interest in full.

Fourth: The local distribution system is financed by the issue of municipal debentures. Provision is made in the rates charged to the ultimate consumers, for revenue with which to retire these bonds also in twenty to thirty years.

Fifth: The Commission supplies power to the municipalities, charging each municipality the actual cost. To do this, an interim charge is made monthly based upon the estimated cost and, at the end of each year, credit or debit adjustment is made of the amount charged in order to make up the actual total cost. The "cost of power" includes all the usual costs of operation and maintenance of the generating, transforming and transmission plant and equipment, and, in addition, the annual interest charges on the monies borrowed for the initial cost of installation, also provision for renewal (depreciation) and sinking fund reserves, as well as a special reserve fund for contingencies.

Sixth: Each municipality sells electrical energy to its own local consumers at rates and under conditions approved by the Commission. The rates charged to its consumers by a municipality are made sufficient to take care both of the cost of distribution, within the municipality, and of the estimated cost of power to be paid to the Commission by the municipality. The cost of distribution is ascertained in a manner identical with that used by the Commission in arriving at its wholesale costs.

Seventh: Under the Power Commission Act, the Commission is required to determine, annually, the actual cost of service supplied to the municipal corporations by the local commission for such strictly municipal purposes as street lighting and the operation of waterworks' pumps and street railways, and if any profit has accrued through the charging of the rate used throughout the year, this surplus is returned to the municipality.

The basic conception of the whole municipally-owned, electrical undertaking as administered by the Hydro-Electric Power Commission of Ontario is a partnership of municipalities formed to obtain power at cost, each municipality paying its proportion of the cost for the

service received. The Commission, acting as agent and trustee for the municipalities, exercises both administrative and constructional functions, and, by application of the principles adopted, has evolved a well-defined and successful working policy for the development, transmission and distribution of hydro-electric power under municipal ownership.

The new Queenston-Chippawa development already referred to is the largest, single hydro-electric power development in the world, and will have an installed capacity of 600,000 horsepower. The general scheme of development comprises an intake structure in the Niagara River at Chippawa; the deepening and widening of the Welland River between Chippawa and Montrose, a distance of 4½ miles; the construction of a canal 8½ miles long from Montrose to the forebay and screen house at a point on the cliff about a mile south of the village of Queenston; and the construction and equipment of a power house, in the gorge, immediately below the forebay.

Previous power developments on the Niagara River utilized only that portion of the total fall of the river which occurs in the vicinity of the falls, and, for the most part, even this amount of head has been inefficiently utilized; but the basic conception of the Queenston-Chippawa development is the utilization of the greatest possible amount of the total fall of the Niagara River between Lake Erie and Lake Ontario at the highest possible efficiency. This plant operates under a head of about 305 feet.

An enterprise which, in less than fifteen years, has reached a stage of development which will soon involve the utilization of 1,000,000 horsepower, some of which is distributed as far as 250 miles from the point of generation; which serves over 380 municipalities, including practically all of the large cities, towns and villages of the province; which has initiated and carried to successful consummation the largest, single hydro-electric development in the world; and which general undertaking represents an investment of $250,000,000, is, undoubtedly, a remarkable achievement in public ownership.

Recognizing the great natural resources of Canada, especially its pulp wood and other timber assets and its minerals, and recognizing also the strategic situations of many of the largest water powers of the country with respect to these natural resources, it may be stated that no large territory has greater promise of satisfactory development through the further efficient employment of its hydro-electric resources than has the Dominion of Canada.

The World's Experience with Rural Electrification

By Harold Evans

Counsel, Rural Electric Committee, Pennsylvania Council of Agricultural Organizations

THIS afternoon a prosperous dairy farmer walked into my office and told me he was going to sell his herd. I knew him as a very successful man. I suppose I looked blank. At any rate, he went on to say that the labor problem was so difficult that he was not going to worry his head about it any more. Within the last few weeks sixty farm laborers from his locality had gone into a nearby mill. He gave case after case where the same sort of thing is happening. So it goes all over the country. In 1910 the rural population of the United States was over 54 per cent of the total. In 1920 it was less than 49 per cent. In the northeastern section of the country[1] not only did this percentage decrease but there was an actual numerical loss in the rural population, and the acreage of improved farm land decreased by nearly five million acres. In the same period over a million agricultural workers in the United States went into other lines of work. Since 1920 the decrease has been even more marked. The Bureau of Agricultural Economics estimates that in 1922 the net change of population from farm to city was about 1,200,000.

Even in this age of spectacular industrialism and commercialism agriculture remains, as it ever has been, the backbone of our economic life. Farming like manufacturing is dependent on power. Few of us realize that in the United States today more primary power is used in agriculture than in any other industry except transportation. It totals nearly 50 million horsepower. All factories combined use only about one-half as much. Nearly 16 billion horsepower hours are used annually on the farms. In addition to this about 30 billion hours of human energy are expended not including the work done by women in the house.

If agricultural man power is to decrease either through shorter hours or a decrease in the number of workers, the loss must be made good by mechanical power.

The problem is a double one: On one side it is to make farm life sufficiently attractive so that the farm hand will prefer it to the mill. This means shorter hours, better living and working conditions and better educational and recreational opportunities. The other side of the problem is to increase the production per worker. The gasoline motor, better roads, the telephone and the radio have all done their bit. But they are not enough. Rural electrification now seems to be the only solution.

Nor will the benefit of rural electrification be confined to the farmer or to the rural population. In the long run the electric industry cannot afford to ignore an existing installed load of 50 million horsepower with a present annual use of 16 billion horsepower hours (approximately 12 billion kw. h.), much of which can be adequately supplied by electricity. Especially is this true when it appears that much of this farm use would be off peak and would increase the diversity of the system load.

[1] New England, Middle Atlantic and East North Central States.

Perhaps, however, the benefits of rural electrification will be greatest of all to the general community. If it can be satisfactorily achieved; if cheap electric power can be furnished to the factory in the village, or to the individual workshop; if the comforts of electric light and the score of household appliances become available in the hamlet and on the farm, the tide of population may again turn from the overcrowded cities. If so, "white coal" will have undone some of the evils of slums and dwarfed lives which have followed the path of her sister "black coal" for a century.

Ten years ago rural electrification existed only in the minds of a few "visionary dreamers" and "impractical idealists." To be sure there were some individual lighting units in operation, and a few large estates in Hanover, Germany, and in the United States had central station service. But any idea of extensive distribution of energy throughout farming sections was out of the question. The central stations everywhere were devoting their energies to building up their urban industrial loads.

During the last decade comparatively little progress has been made in electric farming throughout the United States with the exception of a few communities. Elsewhere, notably in Germany, Denmark, Sweden and Ontario, great strides have been taken. Some progress is also being made in New Zealand, Italy and France. It is the purpose of this article briefly to review the present status of rural electrification in these countries and in the United States.

GERMANY

In Bavaria great progress has been made during the last ten years in the electrification of the rural districts. The total area of Bavaria, including the Palatinate, is a little over 29,000 square miles, about two-thirds the size of Pennsylvania. About one-half is under cultivation; one-sixth is pasture; and the remaining one-third is forest. The improved farmland covers about 12½ million acres; roughly, a half million more than in Pennsylvania and a third of a million more than in Sweden. The total population is about 7,150,000, of whom 30 to 40 per cent are engaged in agriculture. There are 420,000 farms, averaging less than 35 acres. Only 535 have more than 300 acres of arable land.

The progress of rural electrification has been very rapid during the last few years. In 1921 a little over one-half of the rural homes had electric light and one-ninth had power. Within five years it seems probable that practically every farm will be included in the electrified district. Several factors have contributed toward this rapid development. Perhaps the most important are:

(1) The interest of both government and privately owned central stations in promoting rural electrification;

(2) The farmer co-operatives which distribute the energy locally;

(3) The active interest of the farmer himself; and

(4) The inflation of the currency which has encouraged farmers to spend their money instead of hoarding it.

As elsewhere, the distribution has been most effectively accomplished by farmers' co-operatives, which construct and operate many of the rural local distribution systems. These co-operatives purchase the energy from the central stations at wholesale rates and prorate the total cost among their members in accordance with their consumption. This saves large overhead expense and results in other economies. Thus, for instance, the local distribu-

tion lines are frequently run direct from house to house across private property. Naturally, the farmers would not permit this if they themselves did not own the lines. Under this system, the cost to the customer is much lower than would be possible if the central station owned and operated the local distribution system and had to bill each farmer direct.

The uses to which electricity is put are much the same as in other rural communities, except that perhaps the Bavarian wet weather has resulted in more use for drying hay, grain, etc. Hay is electrically dried in one night without the loss of valuable food properties which often occurs when the crops are sun dried. Electric plowing has also been developed to some extent.[2]

Owing to the unstable condition of the currency since the war it is impossible to make any adequate comparison of German rates with those in other countries.

In outlining the progress of rural electrification in Germany, mention should also be made of Hanover, where for over twenty years electricity has been used extensively on some of the large farms. Before the war a number of electric plows were in operation in this district and two-thirds of the rural communities are now electrified. Recently legislation has been passed to subsidize the electrification of a portion of Hanover.

DENMARK

Denmark covers an area of about 17,000 square miles, a little more than twice that of New Jersey, or one-third that of New York. Three-fourths of it, or about 7¾ million acres, is cultivated. The number of inhabitants is about the same as in New Jersey, giving a density of population of slightly under 200 to the square mile. Three-fifths of the population live in the country and three-tenths are engaged in agriculture. There are probably between 100,000 and 150,000 farms, averaging 50 to 75 acres in size. Danish farming is very intensive and its backbone is animal husbandry, including dairying, poultry farming, and raising pigs. Cereals and root crops are grown extensively but mainly as an adjunct to the animal industry.

Prior to 1918 few farms had electricity, but since that time rural electrification has been so rapidly extended that about one-half of all the farms now have electric service. Progress has been interrupted by the recent financial stringency, but its continuation seems assured as soon as economic conditions improve. Electricity is put to the usual farm uses. The motors vary from 5 to 30 horsepower. Machinery is often purchased through the co-operative societies for which Denmark is famous.

At first a number of small electric power plants were built, but these have been mostly replaced by large central stations operated by steam or Diesel engines. There are also two large and a few small hydro stations. Fuel costs are high.[3]

Generation and distribution seem usually to be handled by different companies, but the arrangements between them differ widely. Except in a few special cases, as, for instance, in South Jutland, no government assistance has been given. Consumers' charges vary greatly from year to year, because of fluctuations in the prices of fuels and in operating costs. They are also varied

[2] As illustrative of the demand for electric plows, it is reported that in one manufacturing plant in Germany as many as 160 plows per week have been turned out.

[3] Coal in the middle of 1924 was selling at $6.52 per metric ton, and fuel oil for the quarter ending September 30, 1924, at $21.94 per metric ton.

by a difference in fixed charges depending on whether the plant was constructed at peak prices. For these reasons and because of a great variation in the conditions of the farms themselves, it is impossible to give the costs for electricity to the average farm.

SWEDEN

The total area of Sweden is 173,000 square miles, roughly the equivalent of New England and the Middle Atlantic States. Nearly 60 per cent is forest. Nine per cent is arable and a little less than 2½ per cent is meadow land. The area of improved farmland is about the same as in Pennsylvania—12 million acres. The total population is approximately 6 million. The density of population is therefore nearly the same as in the United States,—35 to the square mile. Eliminating the forests, the density is about 87 to the square mile of cleared land.

Ten years ago rural electrification was practically unknown in Sweden. The large consumers in the cities were the controlling factors in the industry. Then came the war and Sweden was cut off from its main supply of oil and coal. So she turned to "white coal." Today 40 per cent of the 9½ million acres of tilled land has access to electric power. About one-fifth of this electrified farmland is in the north and four-fifths in the richer central and southern portions of the country.

This rapid development has come about through many different agencies, the most important of which are the state owned electric systems in central Sweden, the larger private power companies and the farmers' co-operative societies.

In addition to lighting and the various household electrical appliances, a variety of motors are found on the farms. Motors of 25 to 30 horsepower are used in the north for sawing and in the south for threshing, etc.; smaller motors of 5 to 15 horsepower are used for threshing in the north and central sections; and small motors of 5 horsepower or less are used in the central and southern districts for milking, driving separators, fans, cutters and crushers. Experiments are being tried with electric plowing and new uses for electricity on the farm are constantly being found.

Altogether, about 110,000 kv. a., or a little less than 10 per cent of the total rating of the electric power stations in Sweden, are available for rural districts. About 1,700 small stations, nearly all hydro-electric and many owned by farmers' co-operative societies, supply more than one-half of the total generator power for rural purposes. These have been mostly pioneers in rural electrification in districts where other service was not available and will probably tend to disappear as the distribution systems of the large central stations are extended. Approximately 1,000 of them are direct current installations with an average capacity of about 12 kv. a. and a very short distribution radius. More than one-third of the electrified area is supplied from the three government stations in central Sweden with a combined capacity of 180,000 kv. a. The remainder is supplied by private corporations. The South Swedish Power Company has extensive rural lines and other companies are also supplying rural service.

The farmers' co-operative distribution societies have proved to be the best solution of the problems of distribution throughout a rural district. This method has been adopted in the area served by government power stations. Where the three-tension system is employed the area served by a co-operative is usually 10 to 30 square miles, representing a total of 2,500 to 7,500 acres of arable land.

The installed farm load at present amounts to about 260,000 kw. Of this 195,000 kw. is in south and central Sweden, where the richest farm land lies, and 65,000 kw. in north Sweden, where there are extensive forests and where the farms do not average more than from 10 to 25 acres of arable land. The installed load per acre is about 68 watts for the entire country; 78 watts in the north; and about 64 watts throughout the rest of Sweden. This load is divided roughly as follows:

Use	Entire Country	North Sweden	South and Central Sweden
	Per Cent	Per Cent	Per Cent
Lighting and household use...	31	46	25
Farm motors.....	54	39	60
Small industries, etc.....	15	15	15

The energy consumed, not counting line losses, amounts to about 86 million kw. h., of which about 30 million kw. h. is used in the north and 56 million kw. h. in the rest of the country. The annual energy consumption per acre of tilled land is approximately 36 kw. h. in the north and 18 kw. h. in the south and central districts with an average of about 23 kw. h. for all Sweden. This is divided as follows:

Use	Entire Country	North Sweden	South and Central Sweden
	Per Cent	Per Cent	Per Cent
Lighting and household use..	42	67	28
Farm motors.....	32	13	42
Small industries, etc.....	26	20	30

The load factor varies with the size of the system. In an average district of two to five thousand acres of tilled land it runs from 12 to 20 per cent and in the larger rural systems it runs as high as 30 per cent. Even with a low average load factor the average annual cost for power and distribution, including interest and depreciation but not including the costs of the customers' installations, is 7¼ cents a kw. h. If the electrified area were doubled, it is estimated that this cost would be reduced to 4⅞ cents per kw. h.

The development of rural electrification in Sweden has not been altogether scientific. The great number of small systems is inefficient and results in transmission voltages varying from 500 volts to 30,000 volts. Until lately there has been no standard frequency of current. Furthermore, many of the small plants have been built at war prices to meet an emergency situation. This in fact applies to a large part of the construction and places a heavy burden on the consumer. In the early days, the private companies made the mistake of picking out only the best rural loads and ignoring many possible customers. Experience has, however, proved that if rural electrification is to be effective, it must include nearly all of the farmers in the district and they must be interested in the enterprise from the start. Swedish experience also indicates that the farmers must be satisfied with lower standards of service than the city dweller demands. Through extensive publicity and the friendly co-operation of producer and consumer the farmers have learned that it is better to have central station service at reasonable cost, even with some service interruptions and irregularities of voltage, than to insist on city standards at prohibitive rates.

ONTARIO

The Province of Ontario, Canada, covers an area of slightly over 400 thousand square miles, of which approximately half is forest and another 10 per cent is covered with water. The population is less than three million, of whom nine-tenths live between the Great Lakes and the Ottawa and St. Lawrence rivers. More than half is urban. Eliminating the 200 thousand square miles of forest, the density of population is approximately 18 to the square mile of cleared land. The cleared area nearly equals the total area of New England and the Middle Atlantic States combined, where the density of population is 175 to the square mile including forests. Taking the United States as a whole the density of population is 35 per square mile.

Agriculture is one of the chief occupations. The improved farm land totals about 14¼ million acres. The farms average between 100 and 200 acres. The farmers are well organized, both agriculturally and politically.

The Hydro-Electric Commission of Ontario, created by Act of Parliament in 1908, acts as trustee for a partnership of municipalities in the wholesale generation and transmission of electrical energy. The Commission generates or purchases the necessary current and transmits it to the municipalities. The entire cost is allocated by the Commission among the municipalities receiving the service. Each municipality owns its local distribution system and distributes the energy to the individual consumers, who in turn are charged rates which will cover the cost of the power furnished to the municipality by the Commission plus the cost of local distribution. The fundamental idea is to serve each consumer at cost, including not only interest and operating costs, but maintenance, renewal, depreciation, sinking fund charges, and all other costs entering into the business of supplying electrical energy. Taxes do not enter into the cost, as the Commission is a government agency. In 1912 the Commission served 28 municipalities; in 1923 it served 224 municipalities and about 50 rural power districts, comprising parts of over 100 townships. The total population served is approximately one and a half million, or about one-half of the total population of the province. Of this number, somewhat over one-eighth live outside of municipalities of 2,500 or over.

Prior to 1920 there was comparatively little progress in rural electrification, but since that time great strides have been made.[4] There are now in operation over 1,100 miles of primary lines of rural extensions, serving over 15,000 rural customers. In addition to this there are 40,000 other rural customers in townships and villages of less than 2,500 inhabitants. From 1921 to June, 1924, 856 miles of line were built to serve 6,483 customers—an average of 7½ per mile.

According to estimates based on the 1923 report of the Commission, it appears that in the rural sections there are about 28 customers to every 100 inhabitants; while in the cities and towns of over 2,500 inhabitants the consumers number only about 24 per cent of the population. In both cases, however, the actual number receiving the benefit of the service is of course far greater than the number of consumers. Based on the assumption of four to a family, it appears that approximately 80 per cent of the homes

[4] Progress has been greatly facilitated by the fact that since 1921 the Provincial Government pays 50 per cent of the cost of all primary lines constructed by the Commission in rural power districts.

Further legislation in 1924 provided a similar bonus on secondary lines and equipment.

in the Hydro-territory are "homes electric."

One of the early mistakes made was to allow the most thickly settled rural sections adjacent to large urban centers to obtain service without making provision at the same time to serve the more sparsely settled regions. This resulted in the owners of much of the best farm land being unable to get service, while consumers near large centers were served at very low rates. This has been remedied by the creation of rural power districts, so that nearly everyone in the Hydro-territory can now obtain service. The Commission has adopted the policy of requiring an equivalent of at least three light farm service customers per mile of primary line constructed, as it has so far found it impossible to make the rural systems self-supporting with a smaller connected load.

A uniform system of rural rates is in force throughout the entire province, though the actual price per kw. h. of course differs in different localities, owing to differences in the cost of service. A special study of the rates in Toronto Township in 1922 shows an average price of a little over 6 cents per kw. h., with a considerable net profit to the township. If this profit were eliminated, the price would have been a little less than 4 cents per kw. h. The policy of service at cost has resulted in very much lower rates for the small consumer than are found in most places, and the result seems to support Mr. Philip Cabot's position that the small customer "is the most profitable consumer of all."[5]

A comparison between the figures presented in the 1923 Report of the Commission with those in the recent report of the Engineer Subcommittee of the Federal Northeastern Super-power Committee indicates that the kw. h. production of electricity per unit of population in Ontario is more than twice as great as in the United States and is increasing much faster in Ontario than it is in this country. Low rates and widespread rural electrification are doubtless two of the factors entering into this situation.

[5] *Survey Graphic*, Vol. 4, p. 581.

NEW ZEALAND

The two islands of New Zealand have a total area of a little over 100,000 square miles, approximately the same as that of the Middle Atlantic States. The improved land covers about 18 million acres, a little more than two-thirds of that in the Middle Atlantic States. Of these 16 million are in pasture. The population is about 1¼ million, of whom between 50 and 60 per cent are rural. The density of population is therefore only 12½ per square mile as compared with 265 per square mile in our Middle Atlantic States.

Sheep and cattle raising and dairying form the principal rural occupations. In agriculture the islands about meet their own needs. The average size of the farms in the electrified sections is about 100 acres.

The principal farm uses of electricity are about the same as in other dairying districts. Electric plowing is still in the experimental stage. Electric power is also used in centralized depots for refrigeration, milling and butter and cheese making. Small motors, rarely exceeding 3 horsepower, are usually found on the farms, but much larger ones are used in the central depots.

Practically all the electricity is generated at hydro stations. In the North Island, it is proposed to develop 120,000 k. v. a. in three large stations with the possibility of increasing to 250,000 k. v. a. In the South Island two large stations are in service and additional developments will be made.

The government has divided the islands into power districts and plans to supply hydro-electric power to the entire country. In each power district there is an elective Power Board which purchases energy from the government or, if necessary, builds a central station. It is charged with full responsibility for the retail distribution of electricity throughout the district, and assists individual farmers in financing the necessary electrical equipment.

The distribution lines run along the public roads and the only installations cost paid by the farmer is the actual cost of such part of his service line as exceeds 60 feet in length.

Although about 35 per cent of the agricultural districts have electric power available, rural electrification is still in its infancy. About 6,500 farms have central station service and another 1000 have individual plants. Owing to the low density of population and the economic conditions, the rates have so far been high. The average farm rates are between 14 and 15 cents per kw. h. for light, and between 5 and 6 cents for heat and power. These charges are too high to make it worth while for many farmers to abandon their internal combustion engines and turn to electricity. It seems probable, however, that with the completion of the government hydro stations, the rates will be reduced and rural electrification will progress rapidly.

FRANCE

The area of France is a little over 212,000 square miles. Its population is nearly 37 million, or about 173 per square mile. In these respects, it is therefore practically the exact equivalent of New England and the Middle Atlantic States plus Ohio and Maryland. Agriculture is, as it always has been, the main occupation of the French and about one-half of the population can be classed as rural. Judged by the most recent available figures, which are much out of date, there are nearly 5¾ million farms, more than two-thirds of which are less than 12½ acres in size. The chief crops are grains, beets, potatoes, grapes and hay. The total crop acreage in 1923 was 57 million acres, or about ten acres per farm. In the corresponding area in northeastern United States, there is a little less improved land, but the average improved acreage per farm is more than six times as great.

The uses to which electricity has been put on French farms have so far been mainly limited to lighting and to the operation of presses, dairy machinery and pumps. It has been used to some extent for threshing. Electric plowing has been successful on some large farms, but the cost of equipment is too great for the small ones. The motors usually range from 1 to 10 horsepower. Few large motors are used.

In the electrified rural regions the amount of energy used yearly per inhabitant for light only is about 10 kw. h. of which 8 kw. h. are used by domestic consumers, and 2 kw. h. for public lighting. It is estimated that on electrified farms an average of 1 to 5 kw. h. are used daily for work other than cultivating and harvesting. Most of the electrified districts of France are dependent on fuel generating stations, and the high cost of fuel[6] has resulted in higher rates than would otherwise be necessary. The rates for electricity on farms varied in 1923 from 6 to 9 cents per kw. h. for low tension current, while for high tension current the rates averaged about 3 cents per kw. h. Electric power can be generated in

[6] The latest available prices are: Coal $12.16 to $18.24 per metric ton; gasoline 38 cents per U. S. gallon; kerosene 29 to 30 cents per U. S. gallon.

France much more cheaply in hydro stations than in the fuel burning plants and as rural electrification extends to districts where hydro-electric current is available the rates will doubtless be lower than they are in the rural districts now served. Up to the present time progress in rural electrification has been largely confined to the north of France. The electrified farms are mainly those of comparatively large size; *i.e.*, 100 acres or more. The authorities, however, estimate that within the next few years 20,000 additional communes, nearly all rural and having a population of 10 million, can be electrified.

In 1923, an act was passed authorizing government loans at low interest rates to communes, co-operative societies, etc., to enable them to establish rural electric service. The passage of such an act in the present unsatisfactory condition of French finances indicates the pressure there is for rural electrification. This pressure is due mainly to four causes: (1) the lack of man power and the consequent need of increasing the use of mechanical equipment; (2) the necessity of checking the steady drift of the rural population to the cities; (3) the desirability of maintaining the cottage industries; and (4) the possibility of improving the balance of trade by reducing the imports of fuel through the use of hydro-electric power.

There is every indication that rural electrification will be rapidly developed in France within the next few years.

ITALY

Italy covers an area of about 120,000 square miles with a population of 40 million, or 333 per square mile. Its density of population is, therefore, about 50 per cent greater than the Middle Atlantic States and its area is about one-fifth larger. Accurate statistics as to the area under cultivation, size of farms, etc., are not available. One of the difficulties with agriculture is the water supply. In some parts irrigation is required; in other parts the land must be drained. The high cost of fuel is contributing to the present rapid development of the vast water power resources of the country.

By far the greatest progress in rural electrification has been made in northern Italy, where there is already a net work of transmission lines and where the farmers are more ready to accept new ideas than the farmers in the south. Electricity is there used extensively for pumping, plowing, harrowing, threshing, cutting, grinding, and many other operations. Two important factors in the present development of rural electrification are (1) co-operative distribution societies and (2) a small government subsidy based on the weight of copper in the transmission lines. Those who have studied the problem most carefully in Italy believe that the co-operative distribution societies are essential because (a) the demand for electric power in Italy still exceeds the supply and the companies have little incentive to go into the agricultural field; (b) co-operation is needed to secure a reasonably good load factor and to utilize the expensive farm equipment to the best advantage; and (c) the cost to the small farmer would be prohibitive.

Several of these co-operatives are already in successful operation. In addition to owning the transmission lines and transformers, these societies own electric motors, pumps, plows, etc., which are rented out to the farmers. One group owns over 65 miles of high tension lines, more than 25 miles of low tension lines, and 40 transformer stations. It serves 500 consumers. Another owns over 85 miles of transmission lines and operates 16 plowing outfits. Data as to the rates per kw. h.

are not available, but rates charged by one of the co-operatives for certain operations including the use of the machinery and the services of a trained foreman are interesting. They are as follows:—normal plowing,—$6.10 per acre; harrowing,—$1.86 per acre; threshing rice,—21.6¢ per bushel; drying rice,—10.8¢ per bushel.

The government subsidy is not available to the co-operative distribution societies and is little used by the central station companies because of its comparative insignificance and their inability to meet the demand of their present urban consumers.

UNITED STATES

According to the 1920 census [7] there are about 6,450,000 farms in the United States with a total acreage of nearly one billion. Of these approximately two and a half million, nearly 39 per cent, had telephones and 453,000, or 7 per cent, had gas or electric light, including both those having private gas or electric plants and those connected with public utilities. According to figures gathered by the Rural Electric Service Committee of the National Electric Light Association in 1924, only approximately 166,000 farms, or less than 2.7 per cent of the total, receive central station electric service. In this respect, there is a great divergence among the states, due partly to a difference in conditions and partly to a difference in the attitude of the utilities. Thus, in California over 27 per cent of the farms have central station service, whereas in New York only 3.1 per cent, in Pennsylvania 6.4 per cent, and in Georgia less than 1/20 of 1 per cent receive such service. Figures now being gathered by the U. S. Department of Agriculture in making a national farm power survey indicate there are now 490,000 farms equipped with electricity, of which 300,000 have individual plants and 190,000, or less than 3 per cent of the total number of farms, are connected with central stations. From these figures it is evident that rural electrification has lagged in the United States, taking the country as a whole. Today, however, both the farmers and the industry are coming to realize that it is both desirable and possible. Valuable investigations have been carried on both by the private companies and by government agencies, such as the U. S. Department of Agriculture, the Federal Power Commission, the Giant Power Survey Board in Pennsylvania, the Pennsylvania Public Service Commission and state universities.

The demand for electric service in the rural sections is becoming more and more insistent. A comparison of farm conditions in unelectrified rural sections of the United States with those in electrified districts in this country and elsewhere indicates no reason why this demand should not be met. Taking the United States as a whole, there is utilized on farms an average of 8 h. p. (6 kw.) per farm, exclusive of man power. As very little power is used in the south this average for the rest of the country is considerably higher. It is increasing annually at the rate of ¼ h. p. per farm. Approximately 2,400 h. p. hours (1,800 kw. h.) are used on the average farm yearly or about 31 hp. h. (24 kw. h.) per improved acre. Electricity could not only supply much of this but could also relieve the farmers of a considerable part of the 30 billion hours of energy which they annually expend and save the women from much of the drudgery of household work. Rural electrification of the United States on a wide scale and at an early date has become inevitable. The only question seems

[7] See Table I.

TABLE I

States	Rural Population	Per Cent of Total Population	Acres Farmland	Per Cent of Total Land	Number of Farms	Average Acreage of Farms	Average Acreage of Farms—Improved Land	Average Value per Farm	Average Value of All Farm Property per Acre	Per Cent Having Automobiles, 1920	Per Cent Having Telephones, 1920	Per Cent Having Gas or Electric Light, 1920	Per Cent Having Central Station Electric Service, 1923
New England.....	1,535,836	20.8	16,990,642	42.8	156,564	108.5	39.1	$7,492	$69.05	25.7	51.4*	15.3	10.2
Middle Atlantic.....	5,588,549	25.1	40,572,901	63.4	425,147	95.4	62.5	9,290	97.38	35.2	44.5	14.1	4.7
East North Central...	8,426,271	39.2	117,735,179	74.9	1,084,744	108.5	81.0	15,898	146.52	47.3	62.6	10.5	3.0
West North Central...	7,816,877	62.3	256,973,229	78.6	1,096,951	234.3	156.2	25,517	108.91	57.6	69.5	8.9	1.8
South Atlantic.....	9,651,480	69.0	97,775,243	56.8	1,158,976	84.4	41.9	5,292	62.70	16.2	14.2	3.9	.6
East South Central....	6,899,100	77.6	78,897,463	68.7	1,051,600	75.0	42.2	4,203	56.04	7.8	18.7	2.1	.7
West South Central...	7,271,395	71.0	173,449,127	63.1	996,088	174.1	64.4	7,652	43.95	17.4	27.4	1.9	.4
Mountain.....	2,121,121	63.6	117,337,226	21.3	244,109	480.7	123.3	16,727	34.80	37.6	25.6	10.3	4.5
Pacific.....	2,095,388	37.6	56,152,705	27.6	234,164	239.8	102.2	22,664	95.76	47.2	38.7	19.3	21.7
United States.....	51,406,017	48.6	955,883,715	50.2	6,448,343	148.2	78.0	12,084	81.54	30.7†	38.7	7.0	2.6

* These percentages are much too low for 1923. From Jan. 1, 1920, to Oct. 31, 1924, the increase in Bell owned and connecting telephones in the U. S. was 3,937,776.

† The Bureau of Public Roads of the U. S. Department of Agriculture estimates that the number of automobiles on farms has doubled since January 1, 1920. See *Annals* American Academy, Vol. CXVI, p. 12.

to be whether private companies will act energetically enough to check the growing demand for public ownership.

It must not be supposed that there are not parts of the United States where real progress in rural electrification has been made. In some cases this has been due to progressive management of private companies; in others to public or co-operative effort on the part of a local community.

California shows a larger percentage (27 per cent) of farms having central station service than any other state. This is partly due to the large amount of power needed for pumping for irrigation purposes, and partly to the fact that low rates are available for rural consumers. Thus, one large company has an agricultural power service with a monthly demand charge of 25 to 50 cents per h. p. and an energy charge of 1.6 cents to 7 cents per kw. h. This rate is available for general farm use, excluding domestic cooking and lighting. A cooking and lighting rate of 3½ cents to 2 cents per kw. h. is also available. A study of the Santa Anna district, near Los Angeles, gives the following average results for rural service of all kinds for August, 1923:

Number of consumers	4,195
Kw. h. consumed per consumer	750
Revenue per consumer	$14.18
Revenue per kw. h.	1.9c

Here, as everywhere, it is evident that low rates and extensive use of electricity are inextricably bound up together.

Waukesha County, Wisconsin, is another interesting example of what can be accomplished. It is primarily a dairy and stock raising region. From over 80 replies to a questionnaire sent out by the Pennsylvania Giant Power Survey Board, it appears that the farms average 129 acres with 84 acres under cultivation. The district is served by the Milwaukee Electric Railway and Light Company, which for the past four years has had a comparatively low rural rate schedule. About 180 farms are served. In addition to lighting the houses and farm buildings, the energy is used for cooking, all the ordinary household purposes, refrigerating, pumping, milking, grinding, etc. From figures furnished by the Company for 1922, the average monthly consumption was 121 kw. h. The rate based on an analysis of bills and on information furnished by the company averages approximately 5 cents per kw. h. Except in the electrification of its farms, Waukesha County is not pre-eminent. It is a prosperous farming community with average size farms. A number of counties in Pennsylvania excel it in the annual value of their crops, etc., per acre and have more cultivated acres per square mile.

There are a number of interesting examples of rural service through the agency of farmers' co-operative groups. Among these is one in Minnesota which purchases electric energy from a municipal plant at Granite Falls at 3 cents per kw. h. and distributes it to its members. These lines have been in operation for nine years. Originally there were 27 farmers on 29 miles of line. Today there are 50 farmers receiving service. The average cost has been 3½ cents per kw. h. with a charge of 75 cents per month for small motors and $1.25 per month for large motors. An annual assessment of $5.00 per customer usually covers the cost of maintenance.

There are compensations for not being pioneers. If one does not blaze the trail he can at least profit by the mistakes of those who have gone before. The very fact that only 3 per cent of the farms in the United States today receive central station electric service makes it possible to plan rural electrification in connection with the

development of Giant Power in a way that would have been impossible a decade ago.

A study of what has been done elsewhere suggests the following considerations in planning rural electrification in the United States:

(1) Widespread rural electrification within the next ten years is inevitable. The only question is one of ways and means. If the private companies do not do it public ownership will be tried.

(2) The mistake made at first in both Sweden and Ontario of picking out the most profitable consumers and leaving out other possible customers in the same district must not be repeated. A district must be electrified as a whole.

(3) Taken as a whole the rural load is a desirable one for the central station. Under proper rates a load factor of 30 per cent or more may often be obtained. Much of the rural load will be off peak and its addition will improve the diversity factor of the system.

(4) It is probably impracticable at the present time to extend lines where there will not be an average of three customers per mile of line.

(5) Both producer and consumer must be educated as to the other's problems. From the start a spirit of fair dealing and co-operation must prevail on both sides.

(6) The rural customer must be satisfied with lower standards of service than are required in the cities. This applies both to interruption of service and to voltage fluctuation, etc.

(7) Rural distribution systems must be financed by the distributing company or co-operative groups and not by the individual consumer. Where the power company is unwilling to finance the system the way should be left open for the formation of a farmers' co-operative group who can purchase energy wholesale from the power company and distribute it among the members. Experience in Sweden and Bavaria indicates that this may often be the best method of distribution.

(8) Rates must be sufficiently low to stimulate quantity consumption. From data now available it appears the average should not exceed 5 or 6 cents per kw. h. Future developments may show it should be much lower. In no event should the rate be based on existing urban rates with a rural surcharge. The rate schedule must be simple enough for the farmer to understand.

(9) It should not be expected that the business will at first offer an attractive return. Other loads now profitable have been built up at rates which were long unremunerative.

(10) Rural systems and the transmission lines feeding them should be interconnected so as to cover large territories. They should be planned with a view to the early development of Giant Power.

(11) Judged by experience elsewhere it is not too much to expect that within the next decade 50 per cent of the farms of the United States will be electrified.

An Electrified Farm

By George H. Morse

Engineering Staff, Public Service Commission, Commonwealth of Pennsylvania

IT was quite late in the evening before Farmer Franklin and his family were willing to leave the sitting room and seek their beds. Early in the evening they had listened to a talk on the present market conditions connected with the disposal of dairy products as it came in, loud and clear, over the radio. This had been followed by a lecture on cow testing in which even Mrs. Franklin and the children had taken considerable interest. Then came a one-act radio playet which set them all laughing, and soon thereafter the room was suffused with the melodious strains of Beethoven's Minuet. At eleven o'clock, Mr. Franklin turned on the switch which lighted the path to the barn and went to take a last look at a sheep about to lamb. An extension cord and lamp made it easy to carry out his examination. When this had been completed he turned on the exhaust fan for a few minutes, which left the building full of fresh clean air for the night. The Franklin dairy produced only the most sanitary milk.

Maximum Work with Minimum Energy

Returning to the house he had sought his bed chamber and was about to cuddle down under his blanket, when a slight disturbance among the fowl in the henhouse caught his ear. "Those chicken thieves again, I suppose," he ejaculated. "I guess they won't take a chance of being potted if I light her up." Reaching up to a point near the head of the bed, he threw a switch which had been carefully arranged for such an emergency. Out in the barnyard there was a sudden glow and the henhouse stood out in sharp relief. Then he went to bed too tired to bother further about thieves, reaching out to turn off the lights in the yard just before he went to sleep.

It wasn't necessary for the farmer to rise early the next morning. There was no hired hand to rouse, grumbling about wanting a job where he could sleep all night. A hired hand was no longer needed on this farm. Son Frank, upon graduation from the state agricultural college, had expressed a willingness to return to the farm if his father would put in modern improvements, including electricity, which would not only relieve them both of much unnecessary toil but add many comforts to their mode of living. A year of experience had now shown that the two of them were quite able to handle the farm without assistance other than that afforded by the electrical machinery and appliances which had been installed. Originally, when the project of electrifying the neighborhood was broached and the public utility representatives had explained that because of the widely scattered farms the utility would derive no reasonable return on the investment for a considerable period, and would therefore be unable to use its own funds without injuring its credit with its investors, the farmers had consented to furnish a part of the money required to build the line. For a time, Mr. Franklin had held back, considering it unjust that he

should be asked to contribute three hundred dollars toward a line, title to which was to be given, out of hand, to the utility company. Frank, however, assured his father that his professors had taught that when a utility takes over a farm line and pays the taxes on it and maintains it indefinitely at its own expense, charging for service a rate which excludes interest on the investment, the farmers who put up a part or all of the money to build the line may easily be better off if title is given over to the utility in consideration of its undertakings. When Mr. Franklin had been brought to this point of view he gave his best efforts toward securing the line and was instrumental in proving to his neighbors that, in holding out for the payment of damages for tree trimming and rights-of-way to pass their farms or cut across them, they were really biting off their noses to spite their faces, so to speak, and that they could hope to secure the line and reasonable rates for service only by showing greater willingness either to moderate or to do away altogether with such demands.

Preliminary showing that his bill for electric service would never be less than five dollars per month regardless of the amount of current consumed had rather staggered Mr. Franklin at first, but a year's experience had shown that after the electric range was installed their monthly bill had mounted to nine or ten dollars. When this occurred they found that any additions to their electrical equipment had very little effect to increase the bill. For instance, an electric heater had proved too expensive to use at first. When the monthly bill was running about six dollars, several dollars were added, evidently owing to running the heater an hour or so on cold mornings. Later, when the monthly bill had risen to nine dollars, because of having acquired a much larger number of electrical appliances in the house and about the farm, running the heater seemed to make very little difference, the same amount of service as formerly had from this device now being measured in cents rather than in dollars. This came about through the effect of the rate charged for electric energy, which rapidly became less as the quantity used became greater.

After the farm was electrified, Mr. Franklin and his son found the labor of milking twenty cows by means of the milking machine comparatively light, the task requiring only an hour. While the machine was at work the two men were able to do other chores in and about the cow barn, such as disposing of the bedding, cleaning the water troughs, preparing the feed, and so forth.

Long before the farmer and his family had arisen in the morning a clock switch had turned on the light in the henhouses whereupon the cocks crowed as lustily as if welcoming the sun, and all the hens came down to scratch. Soon they were singing happily about the task of filling their crops, to the end that they could lay from 20 to 40 per cent more eggs in these winter months than they would otherwise.

RETURNS JUSTIFY EXPENDITURES

Here is a list which Frank's professors prepared and gave him while he was a student in the class in agricultural engineering. It gives the probable monthly consumption of electric energy on the various types and sizes of farms named, for such uses as will be found economically desirable when current becomes available at a practicable, low rate and after the elapse of a sufficient length of time for the

farmers to become acquainted with the real and varied utility of electric power.

	Kilowatt Hours Per Month
Dairy Farm:	
20 cows	265
50 cows	408
100 cows	880
Poultry Farm:	
500 hens	276
1,000 hens	391
1,500 hens	572
Stock Farm:	
20 animal units	197
50 animal units	247
100 animal units	367
Grain Farm:	
25 acres oats, 25 acres corn	187
50 acres oats, 50 acres corn	227
100 acres oats, 100 acres corn	290
Market Garden:	
10 acres, 3 glass houses each 200 feet by 30 feet	450
Fruit Farm:	
20 acres	170
50 acres	175

The average cost per kilowatt hour (a kilowatt hour is the quantity of energy consumed by an ordinary 50-watt lamp burning 20 hours) which such farms will have to pay for electric energy is likely to range between five and seven cents in the greater portion of the agricultural districts in the United States for some years to come. This, of course, includes any so-called minimum or fixed monthly charge named in the public utility rates.

The Franklins are immensely pleased with their electric service and nothing could induce them to part with it. They have been so successful that they are now planning to increase their farming operations. With the help of his former professors Frank has prepared an estimate of the electric energy required based on increasing the herd to 50 cows. Here is the estimate in detail:

ELECTRIC POWER USED ON A DAIRY FARM

50 Cows

	Kw.h.
Grain ground, per year, lbs. 70,000 at 1 kw.h. per 100 cwt.	700
Hay, alfalfa or clover cut and elevated per year, lbs. 100,000 at 2 kw.h. per ton	100
Silage, lbs. 300,000 cut ¾" long, elevated 40 feet at ½ T per kw.h.	300
Water for cows, 182,500 gallons at 1 kw.h. per 1,000 gallons	182
Water for 8 horses, 40,000 gallons at 1 kw.h. per 1,000 gallons	40
Water for garden, lawns and washing automobile, 1,000 gallons	5
Water for pigs and young stock	10
Water for home (10 people) at 30 gallons—109,500 gallons	109
Ventilating fans in cow barns 500 hrs. at ⅔ kw.	330
Cream separator, 10,000 lbs. of butter fat—260,000 lbs. milk. (Churn 200 batches of butter of 50 lbs. each—each batch takes ⅓ h.p. and requires ½ hour)	42
Lighting of farmyard, barns and outbuildings	340
Lighting of farmhouse	200
Range	1,500
Fan (desk type)	16
Toaster	30
Sewing machine	17
Vacuum cleaner	50
Washing machine	50
Lighting in chicken house in winter	50
Electric iron	72
Milking machines	750
	4,898

Average—408 kw.h. per month.

Frank's mother asked him what her share of the monthly bill is going to amount to, or rather, that portion of the total bill for energy used in the farmhouse. Frank estimates that under the condition of the enlarged herd, the average cost of all the electric energy used (based on rates heretofore in force) will be in the neighborhood of five cents per kilowatt hour. On this basis the figures he prepared for his mother are the following:

MONTHLY COST OF ELECTRICITY USED IN THE FARMHOUSE

	Kw.h.	*Cost Per Month at 5 Cents Per Kw.h.*
Water for home (10 people)	9.1	.46
Lighting farmhouse	16.7	.84
Range	125.0	6.25
Toaster	2.5	.13
Sewing machine	1.4	.07
Vacuum cleaner	4.2	.21
Washing machine	4.2	.21
Electric iron	6.0	.30
		$8.47

We have not named an electrical refrigerator as a part of this farm's equipment. There are in the United States no less than 50,000 electric refrigerators in domestic use; some of these are on farms, and many more will be sold to farmers in the near future.

Mrs. Franklin no longer spends fifteen valuable minutes every day cleaning and trimming oil lamps and as much or more of her time lugging water from the well. Frank and his father are men of business. They are running a factory which produces milk. They have time, money and energy at their disposal to give to the development of the higher economies and economics of their business and they look forward to lives of comfort, culture and happiness in a calling which has hitherto contained far too much of drudgery and poorly requited toil.

The Franklin farm with its electrical activities is a myth, but it already has its actual counterpart in many places.

There are in the state of Pennsylvania 202,000 farms. If but one-half of these farms were to be electrified and their consumption of energy individually should average that of the Franklin farm as described with its 20 cows, namely, about 200 kilowatt hours per month, the total consumption of electrical energy for the farms of the state would be 242 million kilowatt hours per annum. This quantity of energy sold at five cents per kilowatt hour would amount to $12,000,000, which would be added to the gross income of the central stations of this state, and nearly as much more would be added from customers in rural districts who are not farmers. Twenty-four million dollars to be added to the income of the electric utilities of Pennsylvania through rural electrification is no mean part of the total income which they derive as measured by its economic significance.

The Use of Electricity in Bavarian Agriculture

By Count Hugo Lerchenfield

Member of the German Reichstag and formerly Minister-President of Bavaria

Bavaria is a typical farming country. In the northern and eastern parts of Germany large estates predominate. In the large industrial districts, as along the Rhine, the soil is divided up into small holdings.

In Bavaria the average percentage of the population engaged in agriculture is larger than the German average taken as a whole (about 40 to 30 per cent). Of the 420,000 Bavarian farming establishments 90 per cent are medium-size farms worked by the owners and yielding a livelihood for one family. Of the remaining 10 per cent only 535 belong to the class of larger estates comprising more than 300 acres of arable land.

Only the most careful management and constant renovation of the soil can make it possible for modern farming in the old countries where the soil has been under cultivation for centuries to compete with world production. Such intense cultivation involves heavy expense and threatens to raise the prices of agricultural products beyond the prices of the world market. Only extreme economy in the use of human labor can offset the cost of fertilization, etc., and in this necessity for economy electricity comes to man's aid most efficiently.

It is difficult to imagine that two generations ago some remote farms were lit by a wooden torch on the hearth. This illustrates best what comfort and safety electric light has brought into the farm houses.

We must dwell at greater length upon electric power as a factor in agricultural progress both as regards machinery and different technical applications.

For outdoor machinery, in plowing and transportation, the gasoline (oil) motor is used almost exclusively. Electric plows are only practical on those few very large estates which can produce their own power and distribute it easily over a large connected area.

For indoor machinery electricity is fast gaining ground. Thrashing, cutting (fodder, etc.,), cleaning (seeds, etc.,), drying, lifting loads are the chief uses to which electric motors can be applied. The progressive owners of small farms are also beginning to take advantage of these modern inventions.

Aid to Farmers

Farmers all over the world are conservative by nature, reluctant to adopt theories and only convinced by thoroughly tested experience. Generally one progressive farmer in a community will gradually convert his neighbors to the use of more modern methods, but the best channels of propagation are undoubtedly the farmers' associations. These farmers' associations, started about fifty years ago on a small scale, have come to play a prominent part in the development of agriculture which cannot easily be overestimated. Thanks to their number and organization they are in a position to influence legislation in all measures concerning the agricultural population and are in constant connection with public administration. A series of well-founded savings, by means of banks and loans to the farmer at low rates of interest, protects him from usury and helps him over the seasons of tight money conditions or partial failure of crops. Other associations serve more commercial purposes. They are organized and

run in the interests of the specialized production of the district whether it be wheat growing, dairy farming or wine pressing. Smaller local associations own machinery in common and give the small landowner opportunity to avail himself of machinery beyond his means. These organizations have also played a large part in the introduction of electric motor power among the farmers, either by financing installation for communities or by furnishing machinery, motors and other implements at wholesale prices; experts are also at the disposal of the members to advise in selecting and installing electric appliances or machinery.

The three years of inflation also have decidedly affected the use of electricity in farming. The rapid depreciation of the mark, and the impossibility of saving money made it imperative to exchange cash earnings for something more solid than paper marks as soon as possible. Conservative peasants who under normal circumstances would have hoarded their money were driven by the necessity for immediate investment to purchasing all kinds of new improvements. With stabilization and the return to normal financial conditions in Germany the incentive to save has reappeared. This and the extremely heavy taxation of landed property and its revenue will somewhat retard progress for the next few years.

It is difficult at present to prophesy to what extent agricultural *production* can be regulated, hastened or increased by applying electricity. Most of these new methods are still in the experimental stage, carried by scientific institutions. It is a long cry from the laboratory to the field of the average peasant and final practicality can only be determined by the ultimate cost of production. This is especially the case in conducting electric current through the soil in order to promote vegetation. The preservation of green fresh fodder by means of silos has hardly proved to be such a success as to recommend its universal use. This system consists in warming the fodder by means of electric current, thus generating certain microbes which produce chemical disintegration. About fifty such silos are at present running at different experimental stations or on larger estates, so that within a short period of time it should be possible to judge whether they are to become generally practical. As for drying plants which are important in the rainy Bavarian climate, electricity cannot yet compete with steam power, especially where steam is at hand for other purposes. This proves again that there is no general rule in economics and final decisions depend on practical and financial considerations.

PRESENT AND FUTURE USE

It is difficult to establish by statistics to what extent our Bavarian farming population has adopted electricity. On January, 1921, a census covering the rural districts of Bavaria shows that half of the towns and villages were furnished or connected with public electric plants. A little over one-half of the household establishments used electric light and about one-ninth electric power. The farming population is included in those figures, which shows how much is still to be done. In the meantime very considerable progress has been made and there is every hope that within three or four years almost every farmer will have at least the opportunity of supplying himself with electric current for light and power, provided that the lines of distribution for the most part under the control of public authorities (state, provincial self-government in combination with private electrical companies) continue

to extend their network as rapidly as within the last few years. Whether this can be done depends on several conditions. The first condition is the supply of capital at a reasonable rate of interest; the second is the working of the superpower plants, especially those connected with the *Bayern-Werk;* the third condition is the offer of electricity at moderate prices.

The supply of capital must be solved within the limits of the working of the Dawes plan, which for many years to come will rule Germany's financial situation. Superpower plants furnish and most likely will in future secure the requisite of kilowatt hours. Prices for electricity are still comparatively high. While the current is produced under favorable circumstances at 1–2 Pf. ($\frac{1}{4}$–$\frac{1}{2}$ cents) it is sold to the small consumer at a price not quite in proportion to the price of production, bearing an excessive profit to the retailer, even if one considers that about one-fifth of the generated current is wasted during long distance transmission and transformation. Of course it will not be possible for the plant to distribute direct to the consumer, but it should be possible to reduce retail prices by improving and simplifying methods. At present the price for power varies from 7 to 13 cents kw. h., while the price for light is still higher. A motor of 5 horsepower is supposed to consume 4 kilowatts an hour. But of course there is no way of controlling the expense for electricity incurred by a medium-sized farm.

As it was remarked, Bavaria may be considered typical for these conditions and conditions in other parts of Germany can be deducted from above. Certainly careful and special attention is being paid to this important economic question both by individuals and by the state.

The Need for Electricity on the Farm

By John A. McSparran
Master of the Pennsylvania State Grange

THE gasoline engine has revolutionized farm operation. Formerly, tread power was the only kind of power which the farmer was able to use, and but few farmers had that. Most of them depended upon some sort of power that was hauled around the country from farm to farm. When gas engines came into general use, farmers bought them for many purposes and no longer depended upon transient power except for such work as threshing. Since then, many have come to own their own thresher. As a result, familiarity with the operation of machinery, together with the scarcity of help in the house and out, has increased the demand for a power that can be used on a moment's notice and for a variety of services.

There is no power that fits that need like electric power and those who have their own electric plants have developed many uses for the current. These plants have relieved the drudgery of house-work to a very considerable extent. The washing machine and the vacuum cleaner, the pump and the sewing machine have been added to the equipment of the home since the power to run them has become available. The care of such an individual plant is, however, considerable and those who can connect with the larger power plants (*i.e.*, central station service) are more and more seeking such connection.

Here comes the difficulty and the hindrance to a larger power development on the farm. Big power companies do not seem to want country business. They will run their lines right through a property, but are loathe to give the people thus inconvenienced with the poles and towers any of the current that runs over the line.

Those who use power also light their houses. In consequence, farmers are larger users of current than the average city dweller and yet they are cut off by the refusal of the companies to give them power except at prices and under conditions that are well nigh intolerable. The distribution of current from Niagara through Ontario Province seems to indicate that the cost of distribution is not very great and the extra power used by farmers seems to warrant a rate that is reasonable.

In some instances, farming communities are framing companies and building lines in order to get current. In other cases, individuals are furnishing poles and the like as an inducement to the operating electric company for the extension of service out from boroughs and cities. The time has come when these power companies should be compelled to give service or lose all privileges on the highways and over private property. Railroads would no doubt like to stop their trains only in towns and cities, but they give service to every village and small town within reach of their lines. Trolley companies could no doubt economize in operation by not stopping in the open country, where usually only a passenger or two board the car at a stop, but they also give service and practically stop wherever business is offered. Their experience shows that business develops where service is given.

Power companies would likewise find this true—that if they gave service, business would follow the lines and re-

turns would increase as time went on.

The need for more industry in the open places is a very crying one in America. Congestion in cities is not good for the country or for the people who are found in the congested centres. Factories moving out where their employes can have a garden and a shade tree will get more out of them from the production end and develop better citizens than would be the case if huddled in a big city. Electrification of the country side is demanded both through the economic need and for social and ethical reasons.

A Note on Rates for Rural Electric Service

By Morris Llewellyn Cooke
Consulting Engineer, Philadelphia

A NEGLIGIBLE percentage of the farms of the United States now have electric service. Therefore we can consider as in the making the form and content of the schedule of rates to be applied to this new class of service if and when rural electric service is developed.

It cannot too often be recalled that the electrical industry began as a lighting industry exclusively. Forty years ago the idea of using electricity for power—or for anything else but light—was not in anyone's mind. When through technical development the use of electric current for power became feasible the industry made a plan for capturing this new class of business. Long view policies were adopted and concessions made even to the point in some instances of quoting power rates at less than the cost of production. A great social gain was evolved in the process. A volume of business was promptly built up in the economies of which all classes of service have since participated. Other classes of business have come along—urban residential, heating, municipal lighting, suburban, etc. Each has presented its special problems, each has required some adjustment in preconceived ideas and concessions from former practices. Each new class of business has in turn contributed to the unparalled present-day prosperity of the electrical industry.

Now comes the claim of the farmers for this great boon—electrical service. Agriculture is the great power-consuming industry of modern society. And yet from our present outlook we cannot say that even if all the farms were connected up with the electrical transmitting and distribution systems a very material addition would be made to the present total demand for electrical current. Compared with the demands of the steel industry, for instance, farm service must seem to the electrical promoter as small pickings. The service involves a world of detail and possibly some political complexities. On the other hand, if it can be demonstrated that electrical farm service (1) has reached the stage of engineering and economic feasibility, (2) can be made to pay for itself, (3) would prove a real boon to American agricultural life, and (4) is something which the farmers will provide for themselves through the government or otherwise if the private companies do not grapple effectively with the problem—then it would seem to be up to the industry to examine the task from all angles and proceed to make the same type of concessions to capture this business and thus make it contribute to the whole success of the industry that they have in former instances.

Rural service should be considered as standing on its own feet, not controlled in any way or affected by business practices and theories heretofore developed for other classes of service—except as these may have an obvious economic basis when applied to this rural field now recognized as new.

What the Farmer Wants

The most radical change in electric utility thinking will come through completely disassociating rural rates and

service from urban rates and service. Now rural rates are based on the nearby urban domestic lighting rates with something added.[1] This principle is one almost completely inconsistent with the facts. No material progress can be made until the principle is abandoned. There formerly was some basis for the idea but it no longer operates. The farmer probably demands in so-called "service" less than any other class of consumers. He wants reliability rather than frills. For instance, variations in voltage, etc., are not usually of very great importance to the farmer. Nor is he accustomed to such immediate and expensive repair service—known as trouble service—as is considered absolutely necessary in the city. In all rural transactions overheads are invariably on lower levels than urban overheads. The urban domestic user is rarely in a position—either individually or collectively—to provide distribution lines or service as is frequently the case with the farmer.

The farmer is essentially a power user. If all the work of the urban domestic user were to be done electrically there would be no very marked increase in his demand for current. Whereas the farmer has almost a limitless demand for power. Just how much of this can be met by electricity will depend largely on the progress in the invention of appliances adapted to his needs and more particularly on the rates the farmer must pay for service.

Fairly general rural electrification—reaching say 50 to 75 per cent of the arable area of many of our states within the next decade or two—must be considered a reasonable goal in view of all the arguments therefor, financial, political, economic, social, etc. This is not based on discrimination in favor of the farmer, but on due recognition of the special factors which favor him.

[1] "Rates for rural service shall be regular city rates plus a rural charge." National Electric Light Association Code.

FINANCING RURAL SERVICE

Except in the case of co-operatively owned lines the private companies operating should pay for and have title to rural lines. The methods of financing such lines may vary widely. As a general principle of course rural electrification should not become permanently or after a reasonable development period a burden on other classes of service. A variety of plans for customer loans on fair terms and even state co-operation are recognized as possibilities.

In developing suburban business it has been quite the custom to assume a certain percentage of customers before the population or even the number of houses is known. The application of this principle to rural electrification will mean the abandonment of the present practice of not building a line until practically every house along the route is signed up on a contract. Rates especially on new lines might be readjusted every three or five years in order to take cognizance of "prospects" that have not become customers. Local public opinion would probably make itself felt in this matter—more especially if the failure of one or more "prospects" to sign up meant an increase in rates for the rest of the community. The effort should be made to provide rural electrification by community as contrasted with individual action through the establishment of rural power districts and otherwise.

Where through individual and community contributions construction work is undertaken which otherwise might not be financially feasible, adjustments in the burden of such construction cannot be considered as discrimination. This applies to origi-

nal consumers only and not to later additional consumers not participating in the launching of the enterprise.

Finally, as a guide in the framing of a schedule for rural rates, three principles may well be observed. Rural rate systems must be:

1. So simple as to be readily understood by the consumers.

> Practically all current systems of rates which meet the tests imposed by 2 and 3 following are so complicated with details as to mean nothing—except possibly to people in the industry.

2. Designed to encourage a large and increasing use of current.

> Except as the farmer is led to become a considerable user of electricity it will not be possible for electricity to influence agricultural life in any large way. The only way to absorb the admittedly high cost of rural lines is by making them serve the farmer in a large way. Simply to connect up every farm in the country would not have much meaning.

3. Rational *i.e.*, related to actual cost.

> It is of prime importance that, in working out the form of schedule and the rates which such schedule shall include for the several rural communities and several classes of rural service, every effort be made to use only present-day actual costs. This means the abandonment of theories the bases for which are historical.

There would appear to be little or no place in rural rates for the so-called demand charge. Such charges have been made in the past on the theory that a certain section of plant capacity is set aside for every customer's individual use. Even if this theory is still tenable for other classes of service the great diversity in rural use suggests its abandonment in fixing rural rates. This matter is ably discussed by two other writers in this volume. The Indiana Public Service Commission has recently ruled out demand charges on all services below 10 kw. demand which would probably include 98 per cent of farm services.

The cost of the electric current itself will be a relatively unimportant factor in the whole cost of rural service. This will not be true for those relatively few farmers who use current for power on a very large scale. Such users are entitled to the same consideration and rates as are quoted to industrial power users. As this class is not typical of rural consumers generally today, their requirements and service have not been specially considered in this memorandum.

For most farmers the cost of service will be largely determined by two factors: (a) the number of consumers per mile of distribution line and (b) the cost of constructing one mile of such line. Of course the number of consumers per mile of line may vary greatly. It has come to be considered that when the number of prospective customers, *i.e.*, homesteads, is less than three to the mile the problem becomes one for special treatment in each particular case. Therefore this memorandum has to do with rural electrification where there are three or more prospective customers to the mile. This means that the average for the entire length of line which it is proposed to build shall be three or more to the mile. There might, for instance, be a section where for three miles there were no farms if along the remaining seven miles of a ten-mile stretch there were a minimum of 30 farms—thus making the average for ten miles at least three. If distribution lines are extended beyond a point where the prospective consumers

number three to the mile, the farms to be reached by the extension will have to provide a proportionate part of the funds required for the construction.

It has been the experience in Sweden and elsewhere that to make rural electrification broadly successful the facilities must be planned out so as to cover fairly completely a given countryside or area rather than to follow certain specially favorable routes through such territory. When a given territory reaches a predetermined population-density standard, thorough-going electrification seems to be the answer.

ESTIMATING CONSTRUCTION COSTS

It is difficult to give any very simple answer as to the cost of constructing a mile of rural line. Little assistance can be gained by a study of the experience of private companies to date because: (1) their costs apply to small scale and piece-meal construction; (2) such costs include overheads based almost altogether on urban experience; (3) the various elements of such costs have not been subjected to that scrutiny as to accuracy and relevancy that ordinarily accompanies rate investigations before Public Service Commissions; (4) specifications for rural lines are far from having reached even approximate standardization. The Hydro-Electric Commission of Ontario gives $1,200 per mile for overhead and $800 the mile for underground as the cost of farmer lines.

It is my personal conviction that if and when fairly general rural electrification is effected the great bulk of the business should be done at 2,300 volts—certainly less than 5,000 volts.[2] In foreign practice—in Sweden and Bavaria especially—rural distribution lines are standardized at 3,000 volts. The electric service companies show a disposition in such rural construction as is now being undertaken to scale up the voltage. One of the most active service companies in Pennsylvania advocates 13,600 volts for all rural lines. The arguments for this policy as applying to that degree of rural electrification thus far undertaken may be sound, but such arguments have very little direct bearing on farmers' service. It is very debatable whether the extra expense in constructing any line above 2,300 volts should be made a charge against the farmers using the line. This argument would apply with even more force to any line above 4,800 volts. Where it is at all likely that industrial business will develop it may easily be wise policy to provide lines of greater capacity, but such excess over the actual needs of the rural part of the community should be a charge against some other class of service. The Bell Telephone Company does not now permit power lines above 5,000 volts to be strung on the same poles with telephone service. Of course technical developments may make it possible to change this policy. But until it is changed the use of voltages higher than 5,000 will preclude the economy of joint pole lines for telephone and electric service.

One carefully arrived at estimate for a mile of 6,900 volt primary line, single phase and 175 feet between poles is as follows (See p. 56). We are citing this with no thought of its finality but simply to give students of the subject a detailed picture of the problem.

The cost of right-of-way has not been included for the reason that this is an item which is entirely within the control of farmers themselves and may be made prohibitive or done away with altogether as they see fit. When the

[2] Some of my associates feel that the slightly higher construction costs involved in a somewhat higher range of voltages is fully warranted. My goal is general electrification and on the simplest and most inexpensive basis possible. The higher voltages have implications not directly related to cost.

			Min.	*Max.*
Poles—Untreated Chestnut				
20 — 30′ at $6.20		$124.00		
5 — 35′ at 8.87		44.35		
3 — 40′ at 11.25		33.75		
2 — 45′ at 13.75		27.50		
		$229.60	$229.60	$229.60
Cross-Arms				
4-pin arm	.75			
Pins, braces and bolts	.80			
	$1.55	30 at $1.55	46.50	46.50
Insulators				
60 at .35/.65 cents			21.00	39.00
Wire				
No. 4 H. D. bare copper, 16 cents base, 1400 lbs. at 16½ cents			221.00	221.00
Tie wire No. 16 S. C.			2.00	2.00
Labor on poles, expense and labor digging, setting, framing and stringing			240.00	450.00
Drayage of poles, wire, x-arms, insulators per pole $2.50 to $3.50			75.00	105.00
Guying per mile				
At four points of change in direction				
At ⅔ of a dead end per mile				
At 1½ branches per mile				
Labor and material			35.00	60.00
Use of tools			5.50	5.50
Engineering, contingencies and office overhead during construction 10%. 12% on foregoing			87.56	139.03
Supervision			35.00	50.00
			$998.16	$1347.63
Interest during construction at 1¼% on foregoing			17.47	23.58
			$1,015.63	$1,371.21

fact is considered that electrification will add not less than $1,000 to the value of a 150 acre farm, the shortsightedness of demanding money for the passage of a pole line along the highway in front of the farm, or even across a corner of it, may easily be demonstrated.

For a like reason no allowance has been made for the right to trim trees, and the farmers could, if they would, entirely relieve the utilities of this feature of expense by doing it themselves.

There are some costs now in effect, connected with the crossing of one line of wire above another, both as to fees paid for official records and as unwarranted demands by the company above whose lines the new line is to pass. All such costs can be done away with by legislative action.

A service of average length and capacity including meter will cost from $35.00 to $50.00, of which about $11.00 is chargeable to cost of meter and its installation. Especially where the customers are few and far between, indi-

vidual service lines usually require an individual transformer. These vary in cost according to size. For a good sized rural connection permitting the use of a 10 horsepower motor such a transformer would cost around $150.00. Frequently when the houses are fairly near together economy is effected through the use of one transformer for two or more connections.

If, as might be the case if the direction of rural electrification should be assumed by the state, the construction of four or five thousand miles of rural lines should be undertaken as one project and especially if only that part of the construction directly of use to the farmer should be taken as the base in fixing rates, a considerable reduction in cost of service to the consumer might be achieved.

ESTABLISHING RATES AND CHARGES

The rural rate system should provide for: (a) a preliminary fixed monthly charge to be paid by the farmer, whether he uses current or not, plus (b) a two or three step, current charge based on actual current used. Everyone will admit the equity of a group of farmers paying the so-called carrying charges on a distribution line built solely for their collective use and of any one of them paying such charges on the facilities installed for his own particular use (such as transformer, meter and service line) and this without regard to the use made of such equipment in any given period.

The preliminary fixed monthly charge should include: (1) an element covering fixed charges on utility's net investment on extension line (affected in each rural district to be electrified by two variables only, (a) length and type of line, and (b) prospective customers); (2) an element covering maintenance and replacement charges on this line recognizing donations; (3) an element covering fixed charges on facilities paid for by the company and provided for the individual customer's sole use; and (4) transformer losses.

It will make for good feeling and ease of interpretation if these items can be determined in advance and tabulated, and in instances averaged, rather than figured on each individual job where the presence of exceptional conditions may lead to misunderstanding. This will involve adopting one or more standard costs per mile of line, depending on type, specification, etc. Such costs can be made subject to adjustment from time to time.

The percentage of the whole cost to be allowed for taxes, interest on investment, maintenance and replacement varies of course from place to place, from time to time, and with special conditions. Some of the factors which go to make up the rate vary as between the different kinds of materials, *i.e.*, poles, copper wire, etc. These percentages are always fiercely contested in rate cases. From 12 to 15 per cent, however, is a range that might possibly be agreed upon as fair by disinterested persons. Thus the monthly charge to cover this item on a mile of pole line estimated to cost $1,200 might be fifteen per cent of 1,200 divided by the number of customers and prospective customers—say 5—divided by 12 months or $3.00. If the average use by such customers is estimated at 100 kw. h. per month this item would be 3 cents per kw. h. If we used 12 per cent and assume 10 customers per mile this item would be $2.00 per month or 2 cents per kw. h. on 100 kw. h. use.

The charges on facilities provided for customers sole use—at best not a very large item, a fraction of a cent per kw. h. might be apportioned in accordance with the transformer capacity required by each such customer if not averaged.

Transformer losses like fixed charges run on whether service is being taken or not. While the number of customers on a rural line will vary from a minimum of three to a possible maximum of 20 or more, it will probably suffice to base rates on a few average densities, as from 3–6, 7–10, 11–15, 16–20 per mile inclusive.

The energy charge, which of course will be in addition to the preliminary fixed monthly charge, may well be in two or three steps. The first step will be for a minimum amount of current—say 10 kw. h.—at the predetermined wholesale rate, to which will be added an element to cover estimated line losses and another to cover commercial expense—reading meters, rendering bills, etc. This whole item might amount to approximately $1.00 or 1 cent per kw. h. for 100 kw. h. of use. The last step in the energy cost will simply be the wholesale rate—2 cents per kw. h. more or less. In a three step system there would be a medium rate somewhat lower than the primary step and somewhat higher than the third step.

Inasmuch as the charge for current under these proposals is so much below the figure to which the public has been accustomed, it may prove to be good public policy to raise it a trifle, but only of course in order to lower the minimums arrived at as above suggested. Otherwise, the minimums might prove too much of a bar to those who use current principally for lighting and therefore would not be in a position to use a large quantity of current. It is in the general interest to have the largest possible number of consumers share in the expense of providing the distribution facilities.

Customer rates so determined may average, say, 4 to 6 cents per kw. h. for an average use of 100 kw. h. per month by an average of 5 farms to the mile of line.[3] But electric costs are constantly going down and will likely continue to decline for many years to come. So rates, even when fairly determined, must be considered as subject to revision.

Rural rates have heretofore been figured on a straight quantity basis. These are known as flat rates. Where there are a considerable number of customers now paying on this basis the proposed plan with high minimum charges and low current rates may seem excessive. This is almost sure to be the case where current is used for lighting only. In such cases it is common present practice to provide that a customer may hold on to his present rate if the new method of assessing charges does not seem favorable. Before a great while the older system will disappear.

Any such system of rates as that proposed will have a fairly direct relationship to cost and will encourage a constantly increasing use of current. Only as electricity is used freely can it exert any fundamental effect on rural life.

Substantially our proposal means that in any beyond the city location, where the service company does not see its way clear, not only to build extensions at its own expense but to apply the regular urban rate schedule, that rates shall be based essentially on the average whole cost of current at the sub-station plus all the expense beyond this point, including fixed charges.

As we approach the time when the cost of manufacturing and transmitting current will become fairly uniform and standardized, and when the operating

[3] While this method of arriving at a rate structure is somewhat novel, rates quantitatively comparable to this suggested range in rates are in force at a number of points in this country and Canada under private as well as public ownership. Such a low range under any flat rate schedules is impossible.

companies cover ever-widening territories, it will become possible to simplify rates by further averaging of costs. At the present it is quite customary to charge rural electric consumers part or all of the cost of the construction work necessary to provide service. These charges are never based on published cost schedules but invariably on what is charged up on each individual job. Where this plan is followed it implies what is in effect a different rate for each individual customer. It is a far cry from this method to rural rate schedules with state-wide application. Widespread rural electrification will almost force uniformity in rate structure and even uniform rates, except in cases affected by such material variations in cost as to make averaging unwise.

The Miners Turn to Giant Power

By McAlister Coleman
Assistant Editor, *Illinois Miner*

ILLINOIS coal-diggers assembled in convention at Peoria in May, 1924, turned to Giant Power as one of the possible solutions to a serious problem which confronted them. It is probable that no group of organized workers ever found themselves in a more critical situation than that faced by the Illinois Mine Workers' Union (District 12 of the United Mine Workers of America) when they came together for their last biennial convention. With every coal-miner in the state a member of the union, with an organization that has been called "the strongest unit of organized labor in the United States," the very existence of the union was threatened by a combination of circumstances over which the miners apparently had no control. It was then that Oscar Ameringer, the far-visioned editor of the *Illinois Miner*, the weekly newspaper of the union, and President Frank Farrington, of District 12, made a study of the possibilities of Giant Power which resulted in the adoption by the convention of a plan of far-reaching significance.

For the first time in the history of the Mine Workers' Union one of the strongest units in that union went on record as favoring increased production, increased consumption and the stabilizing of the entire industry. And it was through the exploitation of that strange new thing, Giant Power, that these coal-diggers hoped to find the way. Briefly they proposed to set up two huge Giant Power plants at either end of the Illinois coal fields which would manufacture electricity from the burning of coal and would at once provide more work for the miners and cheap and abundant power for the community at large.

Critical Condition of Miners

The desperate need for more work was eloquently voiced in the appeals for relief which flooded the convention from nearly every coal-camp in the district. Out of a membership of 100,000 at least 40,000 miners were out of work, mines throughout the state were closing down and those which were kept open were working less than three days a week. Taking into consideration the families and dependents of the workers, some half a million human beings were faced with want—if not actual starvation.

It is not necessary here to discuss in detail the causes for this widespread unemployment. The three years' contract with the operators which assured peace in the industry had also the effect of driving many of the smaller operators out of the union field. The so-called "snow-birds" who keep their mines open in the hope that a strike will force up the prices of coal, drifted South to the non-union fields when word of the signing of the contract was received. At the same time union operators had difficulties in meeting the non-union competition because of the starvation wages paid non-union labor in the Alabama, Kentucky and Tennessee fields. Add to this a general industrial depression and you begin to realize the critical situation that confronted the Illinois diggers.

As President Farrington grimly put it:

Competition has reached a point where every increase in wages and lowering of hours is followed by a reduction in the organized fields for the benefit of the unorganized. If we follow this tendency to its logical sequence we may imagine a situation when our wages and conditions are so favorable as to put an end to the coal industry in Illinois.

He had hit here on a central problem of labor organization, one frequently discussed by professional economists but rarely so frankly posed by a labor leader. From the standpoint of sympathizers with labor a more intensive organization is one solution. In the case of the miners, however, it is at once a dangerous and laborious one.

There is no blinking the fact that in many parts of this country the rights of miners to organize are ruthlessly abrogated. In hundreds of non-union towns freedom of speech and assemblage is unknown.

CONDITIONS AT MINES AND RELIEF MEASURES

So while there is no thought in the minds of any of the miners' leaders of abating organization efforts, it is evident to the more thoughtful of them that supplementary measures must be employed if the organization is to go forward. It is to their credit that they recognize the difficulties before them and attempt to solve them on their own initiative.

When President Farrington stood up to read his report to the Peoria Convention he was addressing an audience who could understand all the technicalities with which he dealt and could follow with intelligence the solution he proposed. Every practical coal-miner is painfully aware of the chaos into which the coal industry in this country has fallen. The man at the face of the coal is always first to suffer from mismanagement and waste, the twin evils of the industry. Lack of adequate or even modern engineering methods is immediately evidenced in the pay-roll.

It is no news to the miners to be told that the industry at which they make their living is the worst managed in the country. Time and again conventions of miners have called for the nationalization of the mines, not only because they believe that nationalization will improve the conditions of workers but because they are convinced that it is the only final solution. The thoughtful report of the Miners' Committee on Nationalization, which was unfortunately buried by the workings of an inner ring of union politicians, is evidence that the miners, at any rate the more progressive of them, are fully aware of the critical condition of one of our basic industries.

So when President Farrington described the more obvious wastes in the handling of coal he was talking not so much to the miners before him as to the public as a whole. He pointed out that under the present method of mining, one-third of the coal is left in the ground and lost forever. Continuing, he said:

It costs nearly as much to haul a ton of coal from southern Illinois to Chicago as it costs to produce the coal.

It costs more to deliver a ton of coal from the car in Chicago to the bin of the consumer than it cost to mine the coal or to haul it from the mine to Chicago.

If the facts were ascertained it also might be found that it costs nearly as much to remove the ashes, cinders and clinkers from the basement of the consumer and dump them in the lake, as it cost to mine the ton of coal in the first place. The city of St. Louis, for instance, is paying $2.10 for the removal of a ton of ashes.

It also might be proven that the smoke nuisance caused by the present method of burning coal in large cities is inflicting more damage to buildings, fabrics and health, than is represented by the cost of production.

In these few items we have enough waste to equal more than two-thirds of the price

paid by the consumer. There is, however, a greater waste which is due to the present method of utilizing coal.

In their report made for the Smithsonian Institute, Gilbert and Pogue found out that there are, in every ton of bituminous coal, fifteen hundred pounds of smokeless fuel analogous to anthracite, ten thousand cubic feet of gas, twenty-two pounds of ammonium sulphate, two and one-half gallons of benzol, and nine gallons of tar.

These by-products recoverable from a ton of coal have a value of three times the present retail price of coal. Under the prevailing method of burning coal they are irreparably lost to mankind.

In sketching the waste in the production, distribution and consumption of coal, I have not touched upon the waste in human life and capital caused by seasonal employment and prolonged idleness. I believe, however, that a sufficient amount of criminal waste has already been pointed out, to warrant the statement that a more scientific organization of the coal industry would vastly increase the measure of life, comfort and happiness of the coal miners, without increasing the price of light, heat and power to the consuming public.

And then came his proposal which is as follows:

1. A semi-public corporation in which District 12, the operators, the consumers and the state would be represented, so as to safeguard the interests of all these factions.

2. The establishment of one or more Giant Power plants on the Ohio and Mississippi rivers for the manufacture of electricity.

3. An integrated net work of major and minor power lines to make electricity available to every hamlet and farm house in the state.

4. The distillation of coal at or near the Giant Power station, in order to save the by-products of coal which are now wasted.

The benefits anticipated from the plan suggested are:

(1) An increased demand for Illinois coal through
  (a) The substitution of electric light for kerosene light.
  (b) The substitution of electric power for gasoline power.
  (c) The substitution of electric stoves for wood, oil, gasoline and crude oil burning stoves.
  (d) The more extensive use of electrical labor-saving devices in home and farm, such as washing machines, vacuum cleaners, corn shredder, etc.
  (e) The illumination of concrete highways.
  (f) The substitution of artificial anthracite for fuel oil in heating plants.

Other benefits anticipated are:

(2) A marked reduction in the price of light, heat and power at the expense of waste in transportation, selling and delivery.

(3) The stimulation of industry by a steady supply of light, heat and power, at reasonable prices.

(4) The abolition of the smoke nuisance.

(5) Cheaper fertilizer for the reclamation of farm land, and

(6) Steady employment of our members.

Unanimously the Convention voted to employ the funds of the organization for the purpose of obtaining the necessary expert advice to "ascertain the practicability and desirability" of the suggested plan.

Several unforeseen developments have taken place since the Convention to check the energetic prosecution of the plan. There is no doubt, however, that within the near future experts from the engineering field will be sitting at the conference table with the miners' representatives working out together a method of employing the new power that we have learned how to harness and control for the benefit of coal-digger and consumer alike.

How Labor Views the Power Situation in California

By Paul Scharrenberg
Secretary-Treasurer, California State Federation of Labor

CALIFORNIA'S power problem is incidental to the state's larger problem of flood control and water conservation. The nine southern counties, popularly known as "southern California," have a somewhat different situation than obtains north of Tehachapi Pass, the dividing point between northern and southern California. To be sure, both ends of the state have a common interest in conserving every drop of available water.

Under irrigation, California becomes a paradise. Without irrigation, millions of the state's richest acres remain barren wastes. And yet this state, where water is the vital element, permits an average annual waste of 27,000,000 million acre feet from its northern watershed alone to run to the sea. Those 27,000,000 acre feet are sufficient to irrigate 18,000,000 acres. Once brought to the land that water will add billions to the wealth of the state, and increase the products of farm, orchard and vineyard by hundreds of millions annually.

But the loss of this needed water is not the only waste entailed. Incidental to the waste of that water, the state is subject to flood damage running, during seasons of heavy rain-fall, into many millions annually. This flood menace increases as the country is developed. The channels of the rivers of northern California cannot carry the volume of flood waters which pour into them. In the pioneer days the excess water was allowed to escape over the lowlands, to find its way eventually back into the river channel. But with the development of the state these lowlands are being diked and brought under cultivation. More and more have the channels of the rivers been taxed during seasons of flood. The result has been higher and higher levies. The limit has about been reached. It is freely predicted that the next year of heavy rainfall will see large flood losses in northern California. The years 1922 and 1924 were, however, "dry years." The lands that will be endangered by flood with the first year of normal rain-fall were in 1924 a parched plain.

The nine counties of southern California with abundance of water within their reach, find their development slowing down because of water shortage. Parts of the southern counties are subject to even greater flood menace than are the interior valleys of the northern part of the state. But with the Colorado River controlled and the waters brought to the lands southern California would be assured of a water supply constant and sufficient.

California then, both north and south, needs water as few other states need it, while menaced by more water than its river channels can carry to the sea.

There seems to be little or no difference of opinion as to how the two problems presented by too much water in river channels during seasons of heavy rainfall, and too little water on the land can be met. Storage of the excess water, in the ample available storage sites in the mountains would at the same time remove the flood menace, and provide a constant water supply ample for all the needs of the state. In the case of the Colorado River involved in interstate complications, the

Federal Government is regarded as the proper agency for the building of the necessary dams, with the state as agent in the distribution of the water and the incidentally developed hydro-electric power. The only available agency competent to handle the problem in northern California, having in view water conservation as well as flood control, is the state itself. California is fast reaching a point where general state development must wait upon the practical solution of this water problem.

CONTROVERSIES

Conservation of the waters now running to waste is of primary importance to California. Second in importance is the by-product that would result from such storage—hydro-electric power. Water storage would make available enormous quantities of cheaply generated power. The manner of disposition of that power is the bone of contention between the water conservationists on the one side, and the privately-owned power companies on the other. The conservationists insist that both water and power be continued in the possession of the state to be furnished the people at cost of production. The privately-owned power companies insist that the by-product, the power from water development by state and nation, must be reserved for private exploitation. And while these contending sides battle, coordinate development of the state's water resources is brought to a standstill.

Labor in this controversy has unreservedly thrown its influence on the side of the water conservationists and public ownership of power as well as of water. Several local skirmishes have been held between the two groups, with success generally on the side of the conservationists.

RESULTS OF LOCAL ENTERPRISES

Thus Los Angeles, with a local water supply sufficient for a population of not more than 250,000, went 200 miles into the mountains, empounded water and brought it to the city. This enterprise made possible Los Angeles county's present population of more than a million. Incidental to this water development cheaply generated electric power was made available. Privately-owned power companies attempted to take over this power.

The power companies were eventually defeated. As a result Los Angeles is distributing power at much lower retail rates than exacted by privately-owned companies for similar service in adjacent territory. Privately-owned companies selling power in Los Angeles City were forced to meet these municipal rates. As a result, during 1921 for example, the actual cost of all electric service in the city of Los Angeles, exclusive of street lighting and railways, was $8,994,163, while the same service at the regular schedules of rates charged by private companies in adjacent territory would have cost $12,784,230, representing an actual saving to Los Angeles consumers of $3,790,067.

In addition to the savings in rates for electricity, the Los Angeles municipal power plant made a good profit. The audit made of the plant's books by Price, Waterhouse & Company for the year from which the above comparison is made shows that:

(a) Accounting for interest and depreciation, in addition to operation and maintenance expense, according to the practice of private corporations under State Railroad Commission regulation, the earnings of the Bureau of Power and Light for the last fiscal year, ending June 30, 1921, showed a surplus or clear profit of $1,210,833.44 and for the Bureau's total operating

period of 4¼ years a surplus of $1,812,933.37.

(b) Accounting, in addition to operation and maintenance expense, for interest and the annual requirements for paying off the bonded debt from the beginning or inception of the Bureau of Power and Light to the end of the last fiscal year, in accordance with provisions of law for municipal practice, the surplus for the last fiscal year was $1,033,840.44 and for the total construction and operating period $824,726.37.

(c) Accounting for bond interest and annual requirements both for full depreciation and for paying off the bonded debt, in addition to operation and maintenance, "which demands of the project that it concurrently produce twice its original cost," there is a surplus of $860,833.44 for the last fiscal year and still a handsome net surplus for the total financial operations of the Bureau of approximately one-third of a million dollars, and not a deficit.

The Price, Waterhouse & Company audit for 1924 shows savings in rates to Los Angeles consumers of $22,000,000 since the first power bonds were voted. In addition there had been to date (May 16, 1924) profits in excess of $9,000,000 which had been used for amortizing power bonds and extending the municipal system.

In a smaller way throughout the state, municipalities have engaged in the power business with uniform success.

The town of Redding, for example, in December, 1921, purchased from a private company, under condemnation proceedings, the local power distributing system at a cost, including severance damages, of $57,000.

A report of the electrical department submitted to the city trustees, August 5, 1924, by City Manager E. A. Rolison and City Clerk Leslie Engram shows a net revenue of $31,891.97 for the fiscal year ending June 30, 1924.

The gross revenue for the year was $64,903.71 and total expense $33,011.74.

The profits from operation of the system from December 6, 1921, to June 30, 1924, have been disbursed and accounted for in the following manner:

Refunded to the general fund the $10,000 borrowed to apply on original purchase of plant.

Advance payments of $5,000 from consumers for power paid back in full.

Bonds redeemed $2,000.

The sum of $39,115.03 was transferred to general fund and used to pay cost of street and highway paving. For betterments and additions to plant, equipment, furniture, etc., $23, 382.17; making the total disbursements $79,497.20 and leaving "Surplus on Hand," $1,241.85.

The city of San Francisco has been working for more than a decade to bring water from Hetch-Hetchy valley. In this, the city has had at every step the continued opposition of interested corporations. With the necessary dam completed, the city is now at grips with the power companies for the incidental hydro-electric power that will be developed. Irrigation districts that are engaged in this piece-meal water development are having the same experience with power companies, the policy of the power companies being to take over the hydro-electric by-product at low cost, to be re-sold to the very people who pay for the water development at monopoly rates.

Labor is unalterably opposed to this policy.

Power Companies Oppose Legislative Backing

The first serious attempt to co-ordinate this water development with the credit of the state back of it was made at the legislative session of 1921. A bill to that end passed the state senate in the face of determined opposition on the part of the power companies. Whereupon, public-spirited citizens of the type of former Congressman Wil-

liam Kent, of Kentfield, Dr. John R. Haynes, of Los Angeles, and Rudolph Spreckels, San Francisco banker, secured the services of the best engineers, attorneys and financial agents obtainable to draw a model bill to put state credit back of a plan of co-ordinate development of the water resources of the state. The purpose of this measure was set forth in its opening section "To conserve, develop and control the waters of the state for the use and benefit of the people." Gifford Pinchot declared this measure to be the best ever drawn for the carrying out of its declared policies.

The first important endorsement of this measure, the California Water and Power Act, as it was called, came from the 1921 convention of the California State Federation of Labor. It was at once endorsed generally by the local unions. Andrew Furuseth voiced the sentiment of organized labor generally when he said:

> It is almost inconceivable that there can be Californians who will oppose the water and power amendment to conserve for the people of California the full use of the water of the state at cost. It is a proposition so clearly beneficial that one would be tempted to question the good citizenship of objectors unless one knows them to be blinded by self-interest.

The measure was submitted to the electors under the initiative. A most astonishing campaign of misrepresentation was carried on against it. A legislative investigation showed that this opposing campaign had been financed by the power companies, which admitted under the pressure of a legislative committee to expending more than half a million dollars to bring about its defeat. But in spite of this opposition 243,604 votes were cast in its favor.

The identical measure was again placed on the ballot in 1924. Once more did the power companies of the state conduct a campaign of amazing misrepresentation against it. Again did labor, from one end of the state to the other, rally to its support. In this campaign, the California labor group had the backing of the American Federation of Labor, which at its 1923 national convention had endorsed the measure. The late Samuel Gompers in an address to organized labor in California urged its adoption. Said President Gompers:

> The American Federation of Labor at its Portland convention endorsed the California Water and Power Amendment. I urge all wage-earners of California to unite in support of the constructive state power policy outlined in that amendment. Until the issue raised by that amendment is settled it is necessary that the workers of California unite in the effort to sustain the policy therein outlined regarding ownership.

The overwhelming interest in the national campaign overshadowed everything of a local nature in California this election, and again did the opposition of the power companies defeat the water conservation policy set forth in the proposed water and power measure. Nevertheless, the affirmative vote for the measure was increased to 320,000. Eventually, with better understanding of the problem, California will unquestionably adopt the policy so clearly set forth in the twice defeated water and power measure; that is, to conserve, develop and control the waters of the state, for the use and benefit of the people.

The Attitude of Organized Labor

By Samuel Gompers[1]
Late President, American Federation of Labor

MOBILIZATION and conservation of power are no new ideas to the labor movement. Our very existence depends upon the wisdom with which we accomplish these two purposes. We appreciate the potentiality of power—for both good and evil.

In industry we know that production is conditioned by ability to make power the servant of our creative faculties. If we have only the physical power inherent in our bodies, we can accomplish something; if physical power is supplemented by machinery and mechanical power, we can do correspondingly more.

American labor does not oppose machinery. On the contrary, we welcome it as the means of increasing material wealth to raise material standards of living. But we have held that there is a human problem of infinitely higher import than the material. We have held that the principles upon which control of power and its material products is determined, shall give first place to human service and human welfare.

The significance of this fundamental unfolds itself with well-nigh startling emphasis when we consider gigantic plans for superpower. Such integration of power streams constitutes a gigantic vehicle for either domination or service, both as applies to communities and to those associated together in the industrial undertaking. In either case it has not been so difficult to get a vision of the human service to be rendered, but we have not been so successful in finding the methods by which to achieve our purposes.

So far as the technical problems of production and distribution of power are concerned we have made great strides. So far as assuring efficient service to communities at low costs is concerned, we have not yet developed either the agencies or the technique for control in the interest of the public. This is one of our most imperative and important public problems. It is not a problem which can be solved for us, but each social and industrial group must contribute to the solution. Labor welcomes an opportunity to participate in any genuine effort.

As to the internal problems of control within the power industry, the fundamentals will in no way differ. Every group contributing to production has industrial experience of value to continuous progress in production. There should be opportunity for each functional group in the power industry to make its distinctive contribution to the policies of the industry and to participate in the making of those decisions that vitally concern each. In essentials this means according to labor unions' opportunity to perform that constructive service inherent in them. Such a method of organization within the industry would substitute intelligence for force, and would enable group organizations to promote individual initiative and stimulate creative power.

The labor movement stands ready to co-operate on this high plane. In the meantime it is on guard to defend human rights and welfare both of individuals and of communities. We want power controlled for human service.[2]

[1] This article was sent to us by Mr. Gompers from El Paso, Texas, during the recent A. F. of L. Convention. It was his last written manuscript for publication. There are good reasons for believing that even during the eventful trip to the City of Mexico the bearing of electrical power on the future of the labor movement was very much on Mr. Gompers' mind.—The Editor.

[2] For other articles by Mr. Gompers see "Giant Power and its Possibilities, Potentialities and Its Administration," *American Federationist*, December, 1923, and "The Future of Giant Power—Tyrant, Servant or Co-ordinator," *American Federationist*, August, 1924.

Use of Electric Service in Industry

By G. M. Gadsby
Vice-President, West Penn Power Company, Pittsburgh, Pa.

A TEXTBOOK of recent vintage defines electricity as a "something permeating everything!" And in light of present knowledge it is as good a definition as any other. Intrinsically we don't know what electricity looks like, smells like, tastes like, nor of what it is composed. We recognize it as a phenomenon and make use of its applications in various forms of *service*. Perhaps the nearest approach to the use of electricity *per se* is in electrolytic and certain electro-plating processes. Even here the electric current—so called—seems but to furnish the *urge* which makes the ions, atoms, molecules, or what not behave in a manner profitable for the experimenter or user.

A postulate of this article is, therefore, that the electric service company deals in and supplies a service and not a commodity. Long ago we were taught that energy cannot be manufactured—an axiom which may again be put on the defensive but is as yet to be accepted as basic—but it can be transformed, stored, changed from potential to dynamic form and in general adapted for shipment and use in fairly efficient manner.

Electric service is comprised of capacity and energy—producing power and work. Capacity and power are unidimensional; work and energy are areas or integrated values resulting from a plotting of the ordinate of capacity or power along the abscissa of time. Load factor is the ratio of the mean ordinate of the integrated area to the maximum capacity ordinate. In practice these ordinates are not taken at instantaneous values but as averages through a predetermined time interval of five, ten, fifteen minutes or an hour.

Determining Factors and Their Influence

Capacity factor is the ratio of average use during a given interval of time to maximum capacity available for use.

In simpler language load factor is a relative or comparative value indicating how constantly the maximum amount of power required has been kept at work. To illustrate by a simile of less flexible characteristics than those possessed by electric service, suppose a man has a daily task of hauling a load from one point to another with a hill to be crossed en route. To make the grade at the top of the hill he must use for a brief interval the pulling power of ten horses. When on the level four horses will make sufficient headway and on the down slope the load will almost coast, so that one horse to overcome occasional excess friction will be all that is required. At night they all go to bed. Now that man must maintain his ten horses available for work at the top of the hill; for the rest of the time he can unhitch them or, if more convenient, let them loaf in the harness, but he must have them when he needs them and they must be stabled, groomed, doctored and fed to keep them alive and fit for pulling every hour of the year. If it be assumed that one horse will be kept pulling full load all the time, three more pulling half of the time, two more pulling a quarter of the time, and the other four only on the sharp grade of the hill, there may be found to be a relationship between oats and hours of actual work, also the life

may be shortened, more harness required and other *operating costs* increased in relation to hours of use. It is thus plain that the cost of transporting the daily load is the sum of a fairly uniform fixed charge plus a variable operating cost, which corresponds to the commonly called demand and energy components of an electric service bill, and it is at once apparent that the more hours all the horses exert their pulling power the lower will be the total average cost of each horsepower hour of work. So, the higher the load factor the lower the average cost per unit of work.

Diversity factor is the ratio of the highest simultaneous use of capacity to the sum of the maximum use of parts of that capacity at different times and locations during a given interval of time. Suppose the farmer has a field near the hill-top, a quarry adjacent to the down slope and a tread mill along the level stretch. When the load is at the top of the hill he unhitches six horses and they are used first to bring some heavy loads from the quarry, then four are put to plowing, and two on the tread mill work; later two are taken from plowing and used for miscellaneous hauling jobs, while the tread mill horses go back on the main load. Summed up, during the day ten horses have done work requiring a total but not simultaneous exertion of twenty-four horsepower. So the diversity factor is 10/24ths or approximately 0.42 or, as usually rated, each actual horse will take care of demands calling for 2.4 horsepower. The greater the diversity the more valuable each horse becomes and the less becomes the total cost of doing each task.

Power factor is the ratio of real work producing energy to the total apparent energy expended in doing a given task. While the analogy is far from exact an illustration may be taken from our ten horses. The maximum result from the pulling power of all the horses will be accomplished if they pull in unison with tugs and traces of all the horses taut in parallel lines at right angles to the axles of the wagon. This perfect condition is seldom realized. By swinging out a little the lines of force are exerted at different angles and also the maximum expenditure of power by each horse is not exerted at the same moment, with the result that the sum of individual dynamometer readings on each horse would, if extended over the time interval consumed in hauling the load, amount to more work than that actually required for the movement accomplished. The excess apparent work may be likened to the wattless component of an electric induction motor load. It is apparent that were it possible exactly to balance the load requirements with the pulling power of the horses, an even ten horsepower load would actually call for a fraction of an eleventh horse, necessitating the ownership, stabling, care and feeding of an additional horse. So low power factor means added cost both in investment and operating expense and the reflection of this item of expense is to be found to an increasing extent in power schedules.

Here then are the important features of the cost of electric service: Demand and energy components influenced by load factor, diversity factor and power factor, and the greatest of these is load factor!

Our horses, having served their analogical purpose, are now turned out to graze and the terms they were impressed into service to define will be used without restraint.

Load factor may be determined for different periods of time and it is always essential to express the time interval. Daily load factor is of use to determine relationship and diversity value be-

tween classes of service; that is, domestic lighting, commercial lighting and small power, street railway, and large industrial power uses. Weekly load factors taken in relation to daily load factors have significance in showing effect of twenty-four hour industrial operation and the building up of "off peak" loads. Seasonal load factors indicate, when studied in relation to each other, the diversity in character of load supplied—*e.g.*, heavy coal-mining loads from middle autumn to late spring and ice-making and refrigeration load—or the lack of it—in summer. Annual load factors have a bearing on generating capacity required and are of greatest interest to the supplying company. Finally, business cycle load factors have a broad economic interest but must be used on a comparative basis and interpreted only with a knowledge of the character of load supplied. To illustrate, a gaseous shaft mine in normal operation may operate on a load factor of 35 per cent, at half production hoisting three days a week the load factor may drop to twenty per cent, and when producing no coal but necessarily kept ventilated and unwatered the load factor may go to sixty per cent or higher. The composite effect of a coal depression or a strike may therefore be, and has been found in real life to be, an improved system load factor with a greatly reduced system peak demand.

Electric service in a real sense was started with the "Electric Light Plant" in 1882. Up to about 1890 electric service was lighting service. Figure 1 shows a typical daily load curve of a lighting plant.

EFFORTS TO DEVELOP ELECTRIC POWER APPLICATIONS

Striving to "fill the valley"—meaning improve the station load factor—efforts were made to develop electric power applications and sell daytime energy for such use. The adoption of higher voltage transmission made possible by the commercial development of the transformer in 1890, followed during the next ten years by other important improvements for generating, transmitting and using electric service, permitted the spread of its use and brought success to power sales efforts. By 1900 the use in industry of electric power from an outside source was no longer uncommon. Figure 2 shows a daily load curve of a power generating plant during the time when the chief use of service was for lighting but the power load was being rapidly developed. The central power station resulted from this development. A central power station load curve is illustrated by Figure 3. Ever increasing demands for electric power with the ability to meet more stringent requirements as to continuity and quality of service has in recent years produced the "Superpower" system, which is the linking together of great generating plants with high voltage, large capacity transmission lines operated under one central control and capable of increased efficiency of operation by reason of improved capacity factors of most economical units. Figure 4 is a superpower system load curve.

Turning to industrial plant load curves, the transition from steam to electric drive has required some years with an intervening period of mixed drive, so that load curves truly typical of the power use for an entire plant or operation have not been readily obtainable. An effort has recently been made to secure some curves which will represent the normal use of power in such fundamental operations as steel mills, coal mines, plate glass plants, cement mills, and brick plants. Figures 5 to 9 show these curves for a given working day. Figure 10 shows the

power company system curve as related to the composite groups of coal mines, steel mills and glass plants supplied from this particular system. Figure 11 shows the effect on the average price per kilowatt hour paid by each group under identically the same schedule, the difference in rate being due to load factor conditions.

The practice of all the large electric service companies in making load factor a real consideration in their power schedules is the same. The actual treatment differs as might be expected and depends upon relative investment and operating costs. This not being a treatise on rate making, further comment on rate structures will not be made.

It may be accepted that the power cost of an industrial plant will vary inversely as its power load factor—and this holds whether power be purchased or made on the premises. It does not follow, however, that an industrial plant can profitably be equipped or operated so as to produce the flattest power load curve theoretically possible. Other cost elements enter. Power cost in most manufacturing processes is not a great percentage of total production cost. To the contrary it will probably be found to average less than 5 per cent of such total cost. So there is a limit quite soon reached beyond which it does not pay to go in rearranging manufacturing processes solely to reduce power cost. From another angle, however, it may pay to give close attention to the plant load factor. It is entirely possible that, in plants of a character that the manufacturing process is fairly uniform throughout the day, the power load curve will be found to be an accurate barometer of production. The valleys mean loss due to slowing up of output and an investigation of causes may be profitable. By careful study over several months a par load curve for any plant or operation may be established and the graphic meter chart will then tell an illuminating story. This applies to more than merely the consideration of load factor, as the operator will find that distinctive shapes in the curve correspond to certain activities in the plant or mine which may be controlled either in the quantity of power drawn or in the time of use.

Electric service companies are anxious that their patrons secure the maximum service per dollar of cost. The larger companies maintain service departments, manned by a personnel experienced in electric-driven machinery and willing to join in an intelligent study of conditions prevailing in the consumer's plant to insure an arrangement and use of equipment which will result in maximum load factor, power factor approaching unity, and the greatest diversity in use of power requirements, thereby securing the lowest cost per kilowatt hour and per unit of output of the consumer's finished product. And this is the ambition of every progressive electric service company.

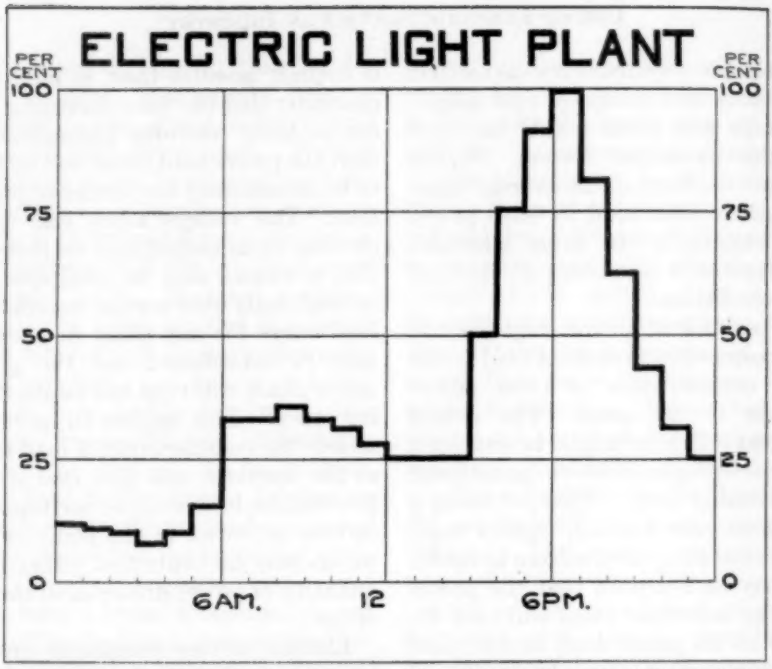


FIGURE 1. Hourly Load Curve taken from *Franklin and Esty's Elements of Electrical Engineering*. Data are from records of a plant having a peak requirement of about 1400 horsepower. The morning peak is without doubt due to lightning service required from 6 to 9 o'clock. Time, about 1903 or 1904.

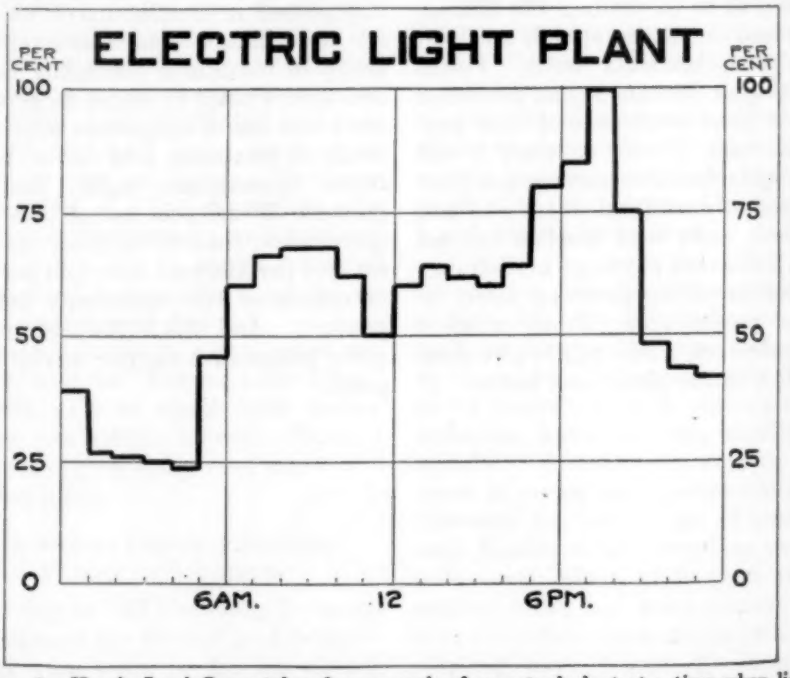


FIGURE 2. Hourly Load Curve taken from records of an actual plant at a time when lighting was still the main use of electric service. Some power business had been developed for this plant. This power load shows the same characteristic morning and afternoon peaks as will be noted on the load curves of power plants of later date.

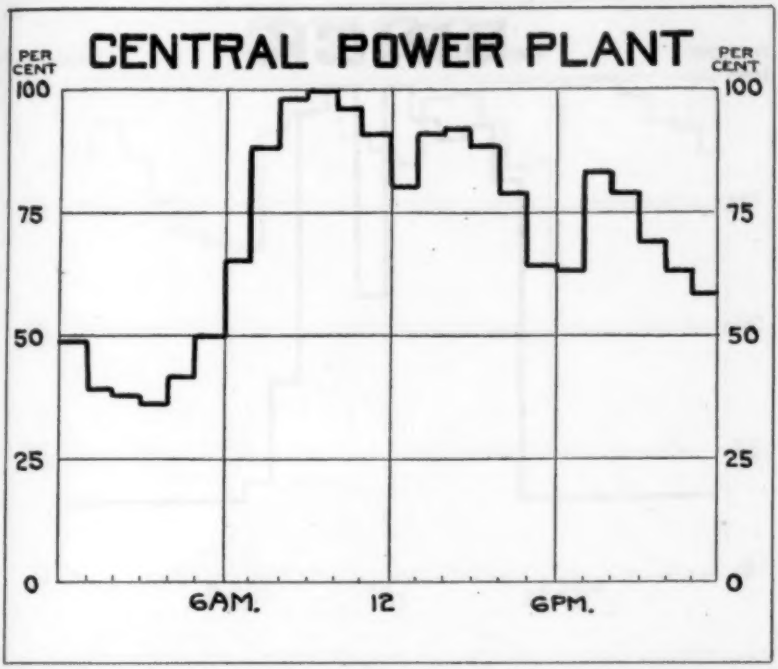


FIGURE 3. Hourly Load Curve taken from records of same plant as used in Figure 2, several years later, when it had graduated into a Central Power Plant of about 50,000 horsepower installed capacity.

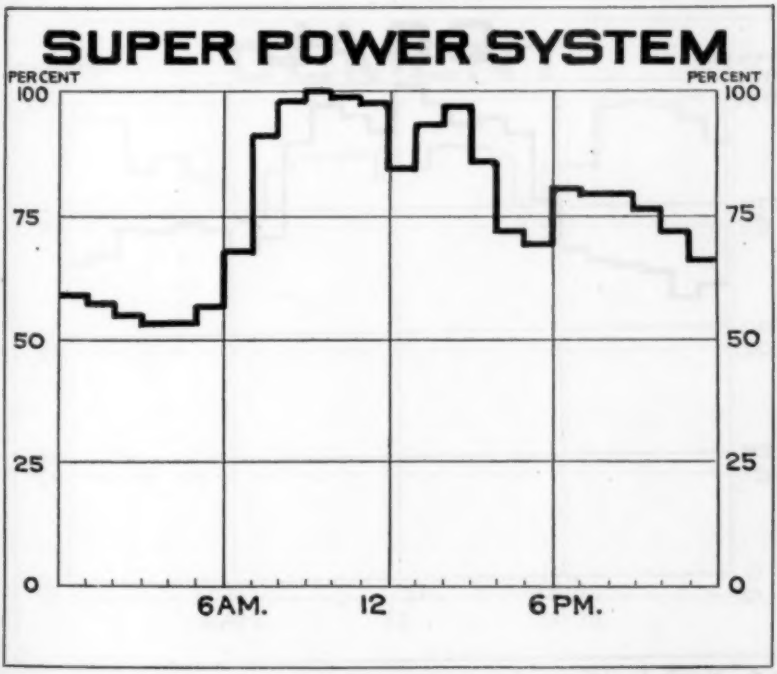


FIGURE 4. Hourly Load Curve taken from records of a system supplying service used in parts of four states. An analysis of this curve by major industries is shown in Figure 10, see p. 76.

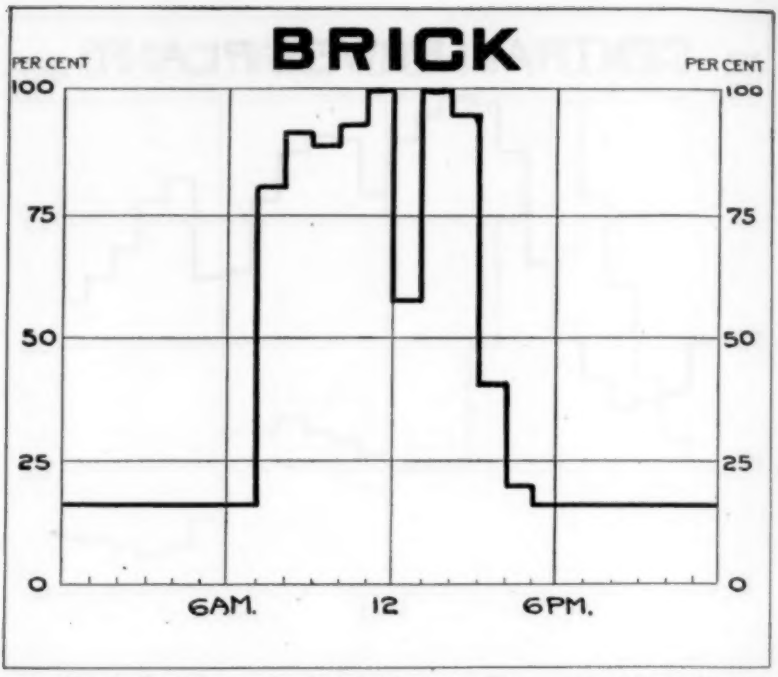


FIGURE 5. Hourly Load Curve of a single brick plant. The curve load factor is 41.7%. This curve is fairly typical of the one shift operation. The data are taken from readings of a graphic meter for a day of usual performance.

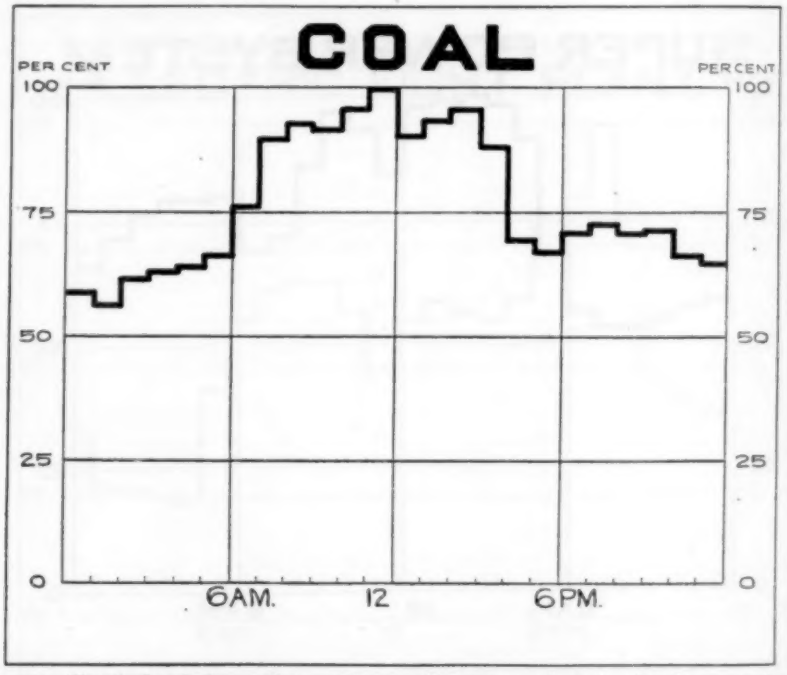


FIGURE 6. Hourly Load Curve of composite graphic meter registration for the same day of 19 different large mines. These include drift, slope and shaft mines. The curve load factor is 76.5 %. This is, of course, much higher than the monthly load factor of mining operations.

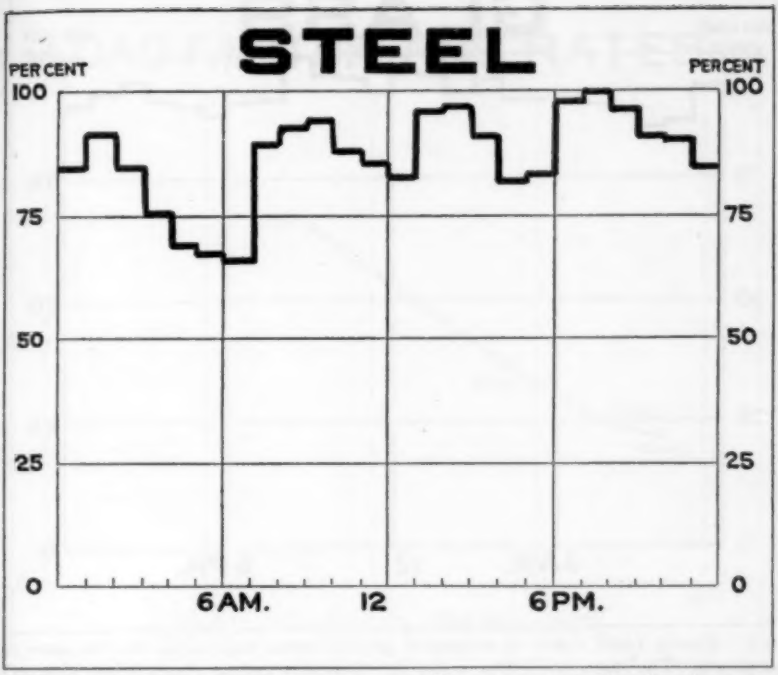


FIGURE 7. Hourly Load Curve of composite graphic meter registration for the same day of 13 steel making and processing plants. Included are electric melting furnaces, rolling mills and wire mills. The curve load factor is 87.2%. The diversity between plants and operations improves the load factor of the composite curve.

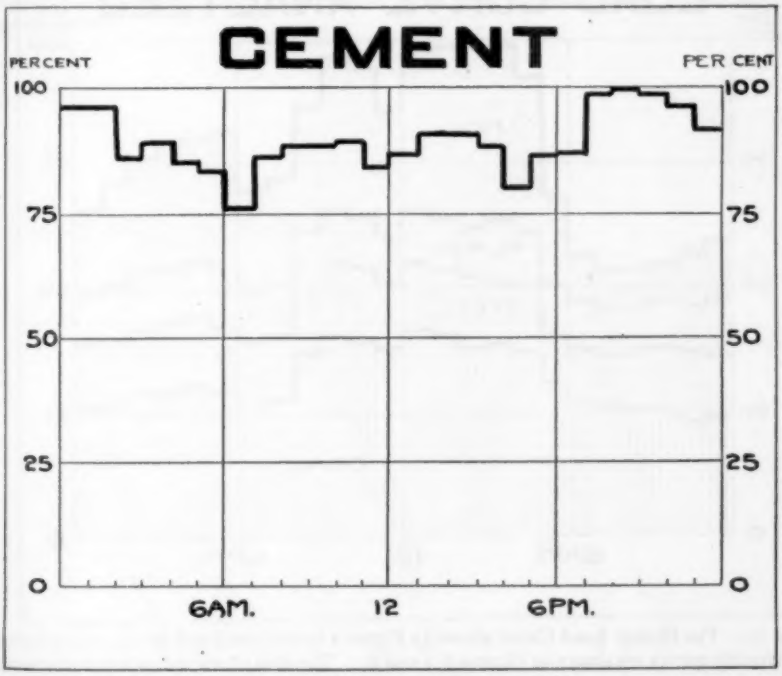


FIGURE 8. Hourly Load Curve of a single large cement plant. The curve load factor is 89.8%. The use in a cement plant of electric power is very constant, resulting in high load factors on both daily and monthly bases.

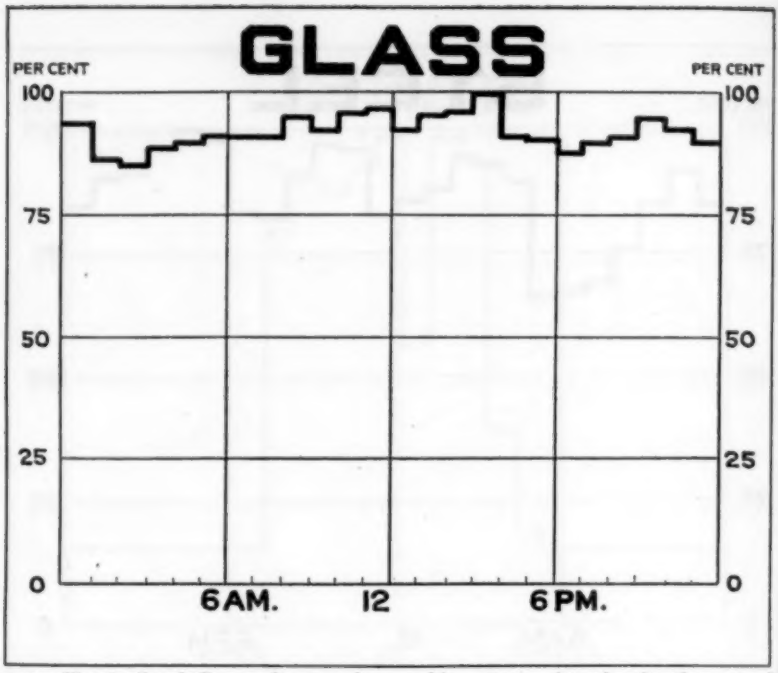


FIGURE 9. Hourly Load Curve of composite graphic meter registration for the same day of 4 large glass plants. The curve load factor is 93.8%. Diversity among plants brings this up but the heavy grinding and polishing in a plate glass plant with many tables in use produces a high daily and monthly load factor for any one of these large plants.

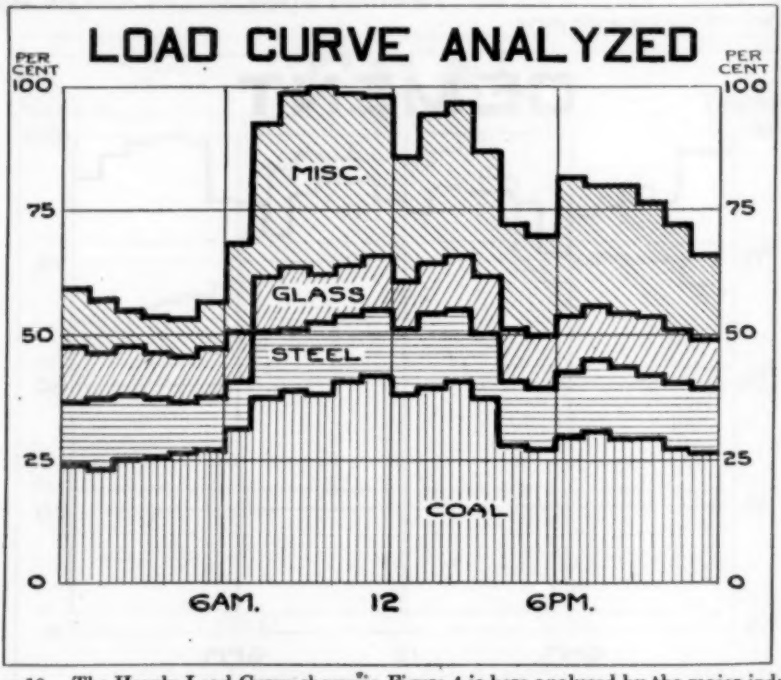


FIGURE 10. The Hourly Load Curve shown in Figure 4 is here analyzed by the major industries whose composite curves are shown in Figures 6, 7 and 9. The area of use indicated as miscellaneous includes much power service and all domestic commercial and municipal lighting and small power use. It will be noted that the morning and afternoon peaks are accentuated by the one shift manufacturing operations, street railway use, and small commercial power requirements.

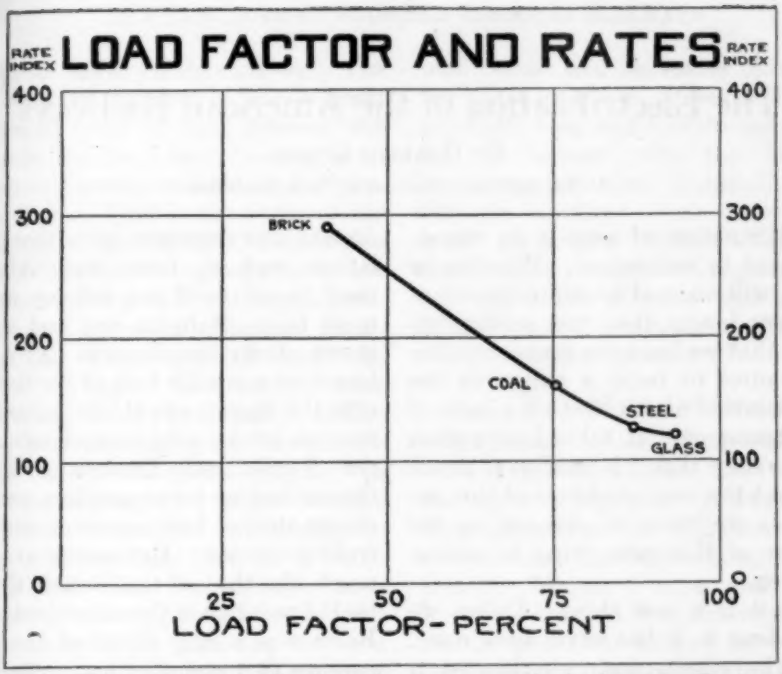


FIGURE 11. This curve has a qualitative rather than a quantitative interest. The hourly load curve factors derived from Figures 5, 6, 7 and 9 are plotted against ratios of average rates per kilowatt hour paid by all of these respective industries on a given power system. The same power schedule applies to each, the difference in the rate being due chiefly to load factor although the magnitude of the operations and conditions under which service is delivered—voltage, power factor, regulation, etc.,—are also factors.

The Electrification of the American Railways[1]

By Herbert Quick

Author and former member of Farm Loan Board

THIS nation of ours is an experiment in railroading. Whether or not it will succeed is still a question. It takes longer than one century to prove that we have the genius and the self-control to build a nation in the back lands of a continent on a basis of land transport. It takes longer than that to show that it is possible to do so. And yet the very existence of this nation, as we know it, depends on the success of this new thing in nation building.

For it is a new thing. Unless we have done it, it has never been done. There have been empires in the past as great in extent as our republic, and greater. But they have not been industrial nations; or if they were, they relied on something that we can never have—waterways leading close to all their centers of population and out into the world. And, of course, there was never any such life as we are trying to maintain in these days of machinery.

Ancient Egypt was no such experiment. It was a strip of Nile mud from two to thirty miles wide and 750 miles long, and of about the area of Maryland, with desert on both sides, and opening on waterways at the Mediterranean end and on the Red Sea side; and no part of it was over twenty miles from water transport. It was made up of cities based on the rich silt of the Nile. Its commerce extended all along the shores of the two seas, back into the deserts, and drew from primitive populations such as Iowa and Nebraska must revert to if our railway experiment fails. Babylon was just such a bunch of city kingdoms as Egypt, and based on a similar belt of fertile land, only this time it was the irrigable lands surrounded by arid hinterlands along the Tigris and Euphrates Rivers. Greece had no transportation problem except that of building ships and controlling the sea. Her status was very much like that of the British Empire for the past two or three hundred years. Rome was a step ahead of the great empires that preceded her. She knew the value of roads and was the first great road builder. When she took over her first foreign territory, the Island of Sicily, she did as we should have had to do with California if it had not been for the Union Pacific Railroad: She devised a new form of government for it. She pinned her faith to roads as bonds of union. Finally the Roman Empire grew to the dimensions of that of Alexander; and it could not be held together, for her highways were military roads, and her lands back from the sea could not be held together. And yet the Mediterranean was in the heart of it and her commerce swept it with thousands of ships, and only in a few places did her domain reach far beyond its waterways.

Venice, the great Spanish power, Portugal in her great days, Holland, the Scandinavian countries and finally the British Empire have all as business agencies been experiments in nationality through water-borne commerce. Every nation of Europe today is vastly better off for transportation,

[1] This discussion in much more extended form was first presented by Mr. Quick in a series of three articles which appeared in 1922 in the *Saturday Evening Post*. We are indebted to the Editors of that periodical for permission given the author to re-state in abridged form the general argument.—The Editor.

except for railways, than are we. The continent of Europe is like a great outspread hand of land between the Atlantic and the Mediterranean, with waterways sweeping right to the people's doors. That is the secret of the importance of Europe. Civilization after civilization has sprung up by the waterside, and grown to strength, prosperity and union on waterway transportation. They have not been built up by railways. The nations were there first. There is no nation in Europe that is an experiment in railroading as we are. Even Russia, which in her physical geography most resembles the United States, did not amount to much until Peter the Great took her to the Baltic. She has always been struggling, as we have done, with great distances by land. She has not used the railway so intensively as we have done; and it looks as if her experiment in national life without them in larger measure is to be a failure. The persistence of the famine in Russia is very largely due to a lack of operating railways.

The United States is a railway-made nation. When our settlers began their exodus through the gaps in the mountains into the Mississippi Valley, and even across the Rockies to the Pacific Coast, there was no ground for the belief that we should ever see such a civilization in Iowa, Minnesota and the Mountain States, or on the coast, as we now possess. It had never existed in any great hinterland before. It does not exist in any such conditions anywhere else now. Iowa might confidently have been promised a future of cattle ranches and cowboys, with no towns except here and there on the rivers. All the trans-Missouri region wherever there is a scanty rainfall seemed sure to be forever about what Irving described in his *Tour on the Prairies*. A country of grassy plains with corrals and haciendas commanding water rights; of wolves, elk, deer, antelope, bear and buffalo competing for the herbage with the Mexican longhorns; of Arab hospitality and Bedouin hostility; . . . of a pastoral civilization retrograding into darkness and ignorance, supporting a few individuals of great wealth as in Mexico and the Argentine, but not the America we know.

MAKERS OF AMERICA

Our America—the America of today—is the child of railroads, born of them and nurtured by them. It was George Stephenson over in England, rather than the men who forced King John to sign the Magna Charta, and it was Matthias Baldwin and Cornelius Vanderbilt and their fellows in America who made us what we are. The railway came to us in the nick of time, and bound together the zones of a nation already showing signs of being destroyed by the very prodigiousness of its growth. European nations made it an adjunct to their already rather fully developed life. To us it was life itself. We wagered our very existence on it. We built with reference to it. We bet our life on the fact that an agency not one-tenth so economical as the water transport, which the human race for thousands of years had depended upon as the basis of every complex communal life, not only could support a life more complex than had ever been known before, spread out over continental distances and practically unhelped by waterways, that it could carry the coal of a coal-burning age and the metals of a steel age, but also that it could bear the burden, increasing in something like a geometrical ratio, of all the tonnage that multiplying population could create in the heart of a continent in a new era when human wants would grow by what they fed

upon. We bet our national life on that and we built our nation in the confident expectation that we should win. It was the nerviest gamble of all history! It will take a long time to tell whether or not we have won it. He who is sure that we have won is over-optimistic. For the railroads of today have unsolved problems—problems that seem almost to defy solution. Some are technical, connected with the actual process of transportation. Some are financial, but the most difficult of all is the problem of gaining the confidence of the public.

UNDERSTANDING THE SITUATION

Said Daniel Willard recently: "I think, however, that the most constant and persistent problem that confronts the railroads at all times, through all seasons and periods, is the problem which grows out of being misunderstood." Mr. Willard proceeded to show that the railways with about 260,000 miles of main line, 2,500,000 freight cars, 55,000 passenger cars, 60,000 locomotives, and a book value which shows up as original cost at about $20,000,000,000, carry about 448,000,000,000 ton-miles in a peak-load year. That is, they carry about 4,000 tons one mile for every man, woman and child in the United States. Or putting it another way, they carry ten tons 400 miles for every man, woman and child.

It is worth while to let those figures sink in, for they constitute the basic reason for this writing. If your family consists of five people the railways carry, in order that you may have a national life and a personal living, a burden of 20,000 ton-miles. That is, they carry for your family of five a ton of freight as far as from New York to Pittsburgh, or from Cleveland to Dubuque, or from Gary, Indiana, to Minneapolis, every week of the year. Every week, year after year. But then, there is your side of the bargain: If the railways carry all this freight each year for your family of five, you must pay the freight. There is no use in trying to evade this conclusion. The freight must be paid. The capital—I am not discussing now how much it is or ought to be—necessary for the carrying on of this huge national task must earn returns on the investment, and you must pay those returns. Even if it were paid out of taxation, still you would have it to pay.

This is the burden which has caused that misunderstanding which Mr. Willard regrets. As the people have become conscious of it they have felt, not that they were between the devil and the deep sea but that the devil was between them and the sea. But though we may ask the sea to help, we cannot turn to waterways for a complete solution. Our wager on the railways must still stand; and in view of past experience our problem is not only to consider the expense of it but to consider carefully as to whether or not the carriers can do the work as it must be done, without reference to expense.

At the outset, two fundamental facts must be emphasized. First, an understanding of the railways by the public is essential to the railways themselves. Second, such an understanding is also essential to the public. The railways depend upon public opinion and always must do so, and the railway question must always be a public question. They will always be dealt with by the national and state governments, which are creations of public opinion. If public opinion be intelligent they will be intelligently dealt with, provided always that railway opinion is intelligent, which it often is not. If both public and railway opinion be unintelligent, ignorant and embittered, the whole vital matter will be handled ig-

norantly, blindly and ruinously. The public does not realize the physical burden which has borne down with greater and greater pressure on the carriers at every time of crisis for more than a generation—ever since our business life attained an approximation to its present complexity; ever since the interior of the continent has taken on anything like a high development.

What are times of crisis for the railways? They are periods of business prosperity. If one goes back to a date prior to the depression in the nineties he will find constant references to so-called car shortages. Shippers generally at certain seasons, and at some places almost all the time, had trouble in getting cars and having secured them, in getting them moved. The hard times which may be said to have begun in 1893 indicate the end of the railway crisis in the beginning of a financial crisis. This should be marked: The transportation stress falls off as the business troubles come on. The depression of the nineties was a period of what the railways call car surplus, exactly such a time as we are suffering from now. (This was written in 1922.) Times were bad, and all the business the nation was trying to do the railroads could handle so far as transportation was concerned.

THE GROWTH OF TONNAGE

The next period of stress came with the next revival of general business. The fact that a certain thing was written at a certain time sometimes gives it additional value; for that reason allow the writer to quote here what he wrote in 1907 or 1908 and published in a book entitled *American Inland Waterways:*

> The outlook is made more interesting, not to say more ominous, by the tendency of business to grow to the limit of any increase in railway facilities. . . . The tonnage will in all probability be doubled in ten years of (railway) rehabilitation. Good agriculture in the Mississippi Valley would break the railways' backs with freight. North Dakota, for instance, grows only half as much wheat an acre as Connecticut, while she should produce twice as much. Coal and iron are almost certain to double in ton-miles. Building materials are sure to be heavier. The nation's business yielding 79,000,000,000 ton-miles in 1890, 141,000,000,000 in 1900, and 187,000,000,000 in 1905, will, unless retarded by industrial depression, call for the carrying of from 350,000,000,000 to 400,000,000,000 ton-miles in 1916.

Recent railway history—(please remember this was written before our last experience in this line)—teems with proof of the increasing pressure on trackage, car supply and motive power. Like most machines, when the railway mechanism is crowded too hard it not only does not do its best work but fails to work at all. The frightful situation, the historic car shortage of 1907, indicates that we were then approaching that stage. The paralyzed mechanism slowed down until freight cars went only twenty miles a day. Equipment was concentrated on main lines, and remote branches were served by only a train or two a week. Farm products rotted at stations for lack of transportation. Coal was piled in mountains on the docks, while in the fireless homes on the prairies frontier settlers froze and died. Cars were doled out to shippers like allowances of food and water in a famine. The desperation told on the personnel of the railways, and on whole systems such things as timetables and schedules were lost sight of. In despairing efforts to move traffic, trains were thrown together in a multitude of terrible accidents that filled the world with horror. As a disease which manifests itself at the point of weakness, the trouble showed sometimes as a lack of cars, sometimes as lack of trackage, sometimes as lack of motive power. It suddenly came to the industrial world as a shocking surprise that business had expanded until it had reached an absolute limit in railway prostration. "It will require the best thought and best effort of this generation," wrote Mr. Hill to Governor Johnson, of Minnesota, "to avert the evil that now casts

its shadow upon the farmer, the manufacturer and merchant, to arrest the progress of the paralysis that is laying its grip upon the heart of commerce, and to restore the wholesome circulation without which there cannot be life and growth in either individual or the commonwealth." If at this time the situation be any better it is only because a temporary financial depression has cured the car shortage by stopping business.

I am citing these utterances to prove what the conditions were fifteen years ago, because of the fact that so many people try to forget them and to account for the railway paralysis of two and three years ago by saying that it grew out of abnormal conditions. It is certain that the abnormal conditions delayed the breakdown rather than hastened it, for with all our transportation mistakes in the war period there was an intensification of effort, a certain heightening of morale on account of the war, and a system of interchange of equipment, together with a willingness of the public to submit to inconvenience for patriotic reasons, that enabled the carriers to stagger along under an unprecedented load. But the collapse had to come.

I have before me a graphic chart of this so-called car shortage, running from 1907 to 1917. It is published as a bulletin by the American Railway Association. It shows a line that rises and falls—rises when the railways have plenty of cars for shippers and when they can properly move shipments, and falls as the traffic becomes heavy. It shows a car surplus all the time from the end of 1907 to the end of 1912, except for one little dip into shortage in 1909. The years 1909 to 1912 were years of about an adequate supply on an average. At the end of 1912 there was a severe car shortage, and another slight dip into a shortage in 1913. Two years of great car surplus then follow—1914 and 1915. Then like magic, right at the end of 1915 the demand upon the railways for shipping facilities overwhelmed the carriers, and we had 1907 over again. Every business remembers it, for it was but yesterday. It will be known to history as the transportation crisis of 1917–18. It was general all over the country. The president of the New York, New Haven and Hartford at a meeting of the Connecticut Chamber of Commerce afterward stated that it was accompanied by

much suffering and a partial paralysis of business, and a threatened stoppage of transportation. . . . Therefore the question confronting railroads and industries in New England had ceased to be the usual one between shipper and carrier, and has become a question of what the carrier can do for the shipper, and what the shipper can do for the carrier in order to keep New England's industrial supremacy from leaving, and New England from being turned into a rich man's playground.

CAR SHORTAGES AND COAL FAMINES

I cite this statement to remind the interested reader that this great danger is one which threatens not the interior alone but the coast states also, which are built up on railway communication with the interior. New England lives on coal, but she has none of her own. Up to the time of the Great War this country had never known a shortage of bituminous coal and it was the *car* shortage which precipitated the coal famine, as our government's own experts proved. As Senator Reed, of Missouri, recently pointed out:

The undisputed evidence shows that at no time, even after our entrance into the war, would there have been a coal shortage had it been possible for the railroads to have furnished the coal mines cars to be loaded, and in turn to have transported the coal promptly to its destination.

The trouble lies in the fact that with practically the same trackage and the

same system of motive power we are trying to do from three to four times the business of twenty years ago, which was then done with great difficulty and with recurrent crises of railway breakdown.

WHAT IS THE TROUBLE?

What is the trouble? We call the trouble car shortage for want of a better term; but is it owing to the fact that we have too few railway cars? The manner in which things pass suddenly from what is called car surplus to car shortage does not indicate that it is scarcity of cars. From the autumn of 1907 to the spring of 1908 we passed from prostration in car shortage to one of our greatest car surpluses, in four months or less. Between the autumn of 1912 and the first of January, 1913, we went from a great surplus to a most embarrassing shortage. Between October, 1915, and the end of the year we passed from a time when anyone could get cars for anything at any time, to a condition when it might almost be said that nobody could get them for anything.

Now, there was no such fluctuation in the demand as this would indicate. Business may fall off astonishingly under the blight of financial depression or a transportation breakdown, but it can never expand with a rapidity that would absorb all the 1915 surplus and make a car famine in two months. There were as many cars in the latter year as in the former. If they had been moved, the same volume of business could have been done, plus the increase served by the surplus. But shippers could not get so many cars as they had been allowed in the slack period. The cars did not move except through agonizing effort. The railway machine did not deliver in this crisis the same effective energy that it yields in normal times. Something had happened that partially paralyzed the whole machine and threatened to stop it entirely. This could not have been a shortage in cars. They could not use effectively the cars they had. I have talked with skilled railway men who express the opinion that if in any of these crises the railways could have been given all the cars needed at points of origin of freight, it would have made things worse.

J. H. Bibbins, a terminal specialist and chairman of the Terminal Committee of the Western Society of Engineers, makes the point that if traffic could be kept moving, the problem would be much less serious. . . . "The national transport capacity is perhaps more of a function of the forwarding capacity of gateways and the handling capacity of terminals." Now, during the railway crises of which I speak, the terminals are always congested. Cars are lost for weeks and months in the vast mass of them clotted in the veins of traffic in the great railway yards. No doubt the railroads need more cars at times, but Mr. Bibbins has put his hand on the seat of the trouble—*that if traffic could be kept moving*, the problem would be simplified. It is not the lack of cars with the railroads that is their curse. Their curse is a liability to strokes of paralysis of the nerves of movement.

It would seem that the inventiveness of America ought to evolve a better terminal system than we have. It would seem that modern engineering ought to create a system by which empty and loaded cars might be thrown with an approach, the size of the objects being considered, to the manner in which letters are thrown by men sorting mail. That terminals are capable of much improvement I have no doubt; but I do not believe the terminals as such are primarily to blame.

THE SEAT OF THE TROUBLE

I believe the basic trouble lies in the fact that the locomotive steam engine has reached the limits of its capacity, and that the trouble in our railway system lies primarily in that. I believe that if the locomotive steam engine could do its share of the work, the terminals could be kept clear, and that the railways would have been able to handle any volume of traffic that has up to this time ever been offered them. In this I am following the opinions of competent experts, in whose judgment I have confidence.

The lack of railroad movement is what kills business when it produces an overload of traffic. The thing that fails is the machine that moves trains. This is the locomotive steam engine.

This statement will not be agreed with by many engineers; but it will surprise none of them. Most of them will agree with it. To the average reader it may be astounding. The steam locomotive typifies progress in transportation in the public mind. It is hoary with traditions of triumph. The iron horse is another word for railroading. But the iron horse is a wind-broken, spavined creature, which can no longer do the work of an America that wishes to prosper. We have all had the experience, especially in cold weather, of asking the conductor what the trouble is, and getting the reply, "We can't make steam." That is the trouble with American transportation—it can't make steam, only up to a certain point, and that point is far below the power we must have in order that we may carry on this great life of ours.

WANTED: A NEW KIND OF POWER

The steam locomotive is an expensive piece of mechanism, expensive to buy and expensive to operate; but when a railway has bought its engines it has to provide facilities to meet their peculiar wants equal in outlay to 60 per cent of the engine bill. Let me illustrate: Fourteen railways in the Northwestern group, in the years from 1907 to 1919, paid out for steam locomotives the sum of $68,000,000. In the same years they spent $43,200,000 for fuel and water stations, shops and engine houses, shop machinery, turntables, ash pits and the like instrumentalities for meeting the needs of these engines.

This is not an indictment of the steam locomotive. It is an effort to find out what is the matter with American transportation. It is not a conservation article. It would find no fault with the steam locomotive on account of its wastefulness if its wastefulness were not accompanied by inefficiency. This inefficiency it shares with any mechanism or organism that is crowded to the last strenuous effort to deliver the goods. The steam locomotive wavers, staggers, tries to pull the load—and lies down. When it lies down business dies down—your business and mine, as well as that of the railways. If it is in a time of cold weather the failure is laid to the cold. The man out on the plains or at the mines or in the Cotton Belt calls it a car shortage. The superintendent of the great terminal will laugh sardonically at this—there is no car shortage with him. He is buried in cars. There are cars in his terminal that have been there for months, and he knows no more than the dead where they are, and when he finds them they are buried so deep in the graveyard that he cannot get them out. He declares it a shortage of motive power, perhaps. Someone else says it is a shortage of tracks.

Smaller abuses, like the failure of shippers to unload cars, get their share of the blame. But the real trouble lies

in the fact that the great steam locomotives have been built larger and larger, until their maximum size has been reached; that as they build them larger and more complex, operated as they are by mere human beings, they have actually decreased in efficiency for many years; that, as President Howard Elliott says, the railways can't haul bigger trains because they can't build bigger engines and they can't build bigger engines because they can't find bigger firemen. Or to state it another way, to make it possible for the railways to use generally a larger and more powerful engine, even if they could build it and have it properly operated, it would be necessary to reconstruct the roads with broader gauges, stronger bridges, larger tunnels, and higher and wider clearances, on a scale which is simply a railway impossibility, physically and financially.

What the railways need is not more of the same kind of power they have, but a new kind of power.

SOLUTION OF THE RAILROAD PROBLEM

The railways have failed us and must continue to fail us whenever we are prosperous, because they cannot haul the load of tonnage prosperity imposes. The solution proposed is electrification. The proposal is based on the performance of electrified railroads already in operation. It is based on engineering knowledge.

We have several hundred miles of main-line electrification on the Chicago, Milwaukee and Puget Sound. Use of electricity in mountain-grade work and in making up trains, negotiating sharp curves and operating through tunnels with heavy freight trains has been a wonderful success on the Norfolk and Western. Terminal work, as well as a good deal of main-line operation, has been completely tried out on the New York terminals and on the New York, New Haven and Hartford, as well as in other places. Every problem in American railroading has been met by electrification by the systems now in operation.

If electrified by beginning where the greatest need exists, the process might be carried forward rapidly enough to solve the problem of our next railway crisis, which will be upon us within five years. Electrification will enable the railroads to handle with ease the heaviest traffic we have ever had, on the same tracks and with the same terminals we now possess. It will put off the necessity of double-tracking, reducing grades, and otherwise extending our present facilities, for at least twenty-five years, and greatly reduce that necessity when it comes upon us if it ever does. The cost will be very great, but probably no greater than would be the making over of the roads along the lines demanded by steam traffic, and the results would be certain of success, while the ability of the roads to handle the growing tonnage with the steam locomotive with any conceivable expenditure of money is more than doubtful when we consider the growing problems of huge terminals and the definite limits of the steam locomotive under multiplying burdens.

The railroads have resorted to electrification in the past just as they must resort to general electrification in the future, to solve problems that steam could not and cannot solve. The Norfolk and Western after a receivership ending in 1898, faced a grave problem that it could not solve with steam, in its physical obstacles, in the form of a single-track tunnel and its heavy grades in the West Virginia coal fields, where on a stretch of thirty miles there originated daily more than 2000 carloads of coal.

THE N. AND W.'S EXPERIMENT

It had the first 100-ton coal cars ever put in service, the best and most powerful Mallet steam locomotives it could get, and a wonderful steel pier at tidewater, on which these huge cars may be run loaded, and dumped by being capsized bodily into bunkers from which a 5000-ton cargo ship can be loaded in two hours. A physical obstacle existed in the heart of their system. The steam locomotives could not handle the traffic through the tunnel and on the grades. The trouble through the tunnel was ventilation, while on the grades and curves it was lack of power and speed.

The company decided to electrify. They made many mistakes by which, and by the mistakes of others on other systems, the electric locomotive has been perfected to an extent that makes it a safe and dependable engine, though with electricity, unlike steam, further great improvements may be looked for. The electrification solved the problem. Even with electric locomotives in an experimental state the tonnage over the road increased by one-third in the first three months. After that their success was increasingly triumphant. Years ago, so complete was it, the Elkhorn Grade and Tunnel ceased to be obstacles to the success of the Norfolk and Western. The *Railway Electrical Engineer* for January, 1921, says:

> The outstanding and pertinent facts are that a new type of locomotive was made to perform a service never before performed, and was put into service practically without experiment. Difficulties have been surmounted as they appeared, and at no time have the electric locomotives been unable to handle the business that came over the division. Electric operation has made it possible to handle the ever-increasing traffic that is originated on this division. The far-sighted policy of adopting it has been profitable to the Norfolk and Western, and the working out of the problems involved has been a service to all other roads confronted with similar problems.

A NOTABLE PERFORMANCE

Mr. A. H. Babcock, consulting electrical engineer for the Southern Pacific Railroad, made a report on this in January, 1917, in which he said of the Norfolk and Western electrification: "It is safe to say that the average train loading has been increased approximately 33 per cent, and the average train movements practically the same amount; in other words the track capacity has been very nearly doubled." I like to quote the careful and conservative statements of these disinterested engineers and technical writers, most of whom would rather lose a month's salary than make anything but an understatement. Mr. Babcock notes calmly the following fact: "Last May, trouble in the power house cut down the electric locomotives available from six to two in service, of which only one could be used on the hill at a time. As a result sixteen of the largest Mallet steam engines had to be brought in from other divisions in order to maintain the traffic." But I should like to have the reader note that when five electrics were for a short time out of business, it took sixteen of the best steam locomotives in existence to take their places.

On the Milwaukee there are several hundred miles of main-line electrification with current derived from water power. It is straight railroad operation. Its adoption was not a necessity, for though there are heavy grades in this portion of the line, the work could have been done by ordinary means as well as on other lines. Electrification was adopted probably because of the availability of the water power. It has worked as well here as on the Norfolk

and Western, and we glean some vitally important lessons from it.

It effects a reduction of 22½ per cent in the number of trains, and cuts down the time of trains 24½ per cent. It has so improved conditions that 30 per cent more tonnage can be handled in 80 per cent of the time. This means an increase of at least 50 per cent in the capacity of the track, and probably more. But it means more than this, for this added efficiency is in the ordinary operations. When the pinch of a crisis comes electricity shows its merits. It works better in cold weather than in hot since the trouble with the electric motor, when it arises, is from overheating. Thus when the steam engine freezes up and dies, the electric motor is better than ever. In 1917–18, when the weather was bitterly cold and steam engines could not make steam, when the chief apology of the railways all over the country was that they were paralyzed by the cold, when passengers were subjected to suffering, danger to health and financial losses, when tracks were blocked by frozen engines and trains, and tonnage was cut down to the point of actual danger, industries were shut down with great losses, and normal business was prohibited, the electrified division of the Milwaukee ran on schedule time. Often trains running over this division made up two hours of the time lost elsewhere by steam.

HANDLING EMERGENCY OVERLOADS

Other roads with electrified divisions did quite as well. The Norfolk and Western did, though at times their trolley wire was merely a string of icicles. Instead of going dead if not taken to a water tank or a coaling station every few hours, and being babied in a roundhouse half the time, these Milwaukee electrics often run twenty-four hours continuously and have made 766 miles in a day. Instead of lying down when the load limit is increased beyond a certain point, as the steam locomotive does, the electrics can handle an overload of 100 per cent in hard starts and unusual pulls without injury—for they are drawing not on their own power but on a huge power house. All the Milwaukee electrics have ever had to do has been to increase the capacity of the road 50 per cent in normal times; but in crises they can more than double it. In crises they can do the work when steam will not operate the line at all. And this is the thing we must have. Steam works well on its stated load and under good conditions; but we must have a system that, as Artemus Ward once said, can rise to an emergency and cave in the emergency's head. This is where electricity excels. It rises to emergencies. It can carry overloads. It flourishes on bitter cold weather. And it caves in the emergency's head.

On the New York, New Haven and Hartford similar results have been noted. According to A. L. Ralston, mechanical superintendent of that road, there is one failure in every 21,000 miles run by electric, and one for every 4000 under steam. Thus electricity is several times as reliable as steam. Fuel consumption in passenger service averages twice as great under steam as electricity. In freight service it is two and a half times as great. In switching service it is much more than twice as great. Last year the partial electrification of this railroad, according to Mr. Ralston, was saving the road $755,000 annually in its fuel bill.

RESULTS JUSTIFY USE

This road recently put in sixteen electric switchers. Operating in the crowded terminals of New York City and vicinity and through the dense industrial belt of New England it faces a

most acute terminal crisis whenever business gets good. These electric switchers on many occasions have run twenty-four hours a day for thirty days without interruption. Compare this with the steam locomotive! As I have said, the electric locomotive works best in cold weather. It does not have to be turned around. It runs without the necessary stoppages of the steam engine. Its inspection is on five times the mileage of the steam engine. Trains run at a uniform speed and can be dispatched on a close margin. Freight trains can be run at a speed approximating that of passenger trains, and thus keep out of the way. Train crews make fewer delays. Division points on a fully electrified road should be at least 500 miles apart instead of about 100 as at present, and thus a part of the 5 per cent of the train crews' time lost in these division yards would be saved.

Six electric switchers on the New York, New Haven and Hartford take the place of ten steam switch engines. This is important as justifying the confidence of the road in electrification in view of its ample experience. The great terminals are the Gordian knot that must be cut in times of crisis. To cut it requires the speed, the ability to work in all weathers, the reserve of power, and the constant service of the electric. Electrification is the solution of terminal jams.

On the Philadelphia, Paoli and Chestnut Hill electrified divisions of the Pennsylvania Railroad, the schedule is made with such regularity as to amount to 10,000 train miles to every detention. On the Long Island Railroad 532 scheduled electric trains are now operating. On the Erie Railroad between Rochester and Mount Morris the line has been electrified for thirteen years. It has been tied up only once on account of storms, and then for only four hours. Steam tie-ups of ten hours to three days had occurred on several occasions.

In the St. Clair Tunnel the Grand Trunk has been operating electric locomotives for twelve years at a fuel cost of half that of steam locomotives, and delays of even a few minutes have been practically unknown.

Thirty-three electric locomotives have handled the passenger traffic in and out of the Pennsylvania terminals of New York for eleven years. They have made more than 7,000,000 miles with a record of 64,437 miles per detention on account of the locomotives. They have made 11,456 miles for every minute of detention, including electrical, mechanical and man failures. The maintenance of these locomotives over all this long time has been just about one-sixth of that of equivalent steam locomotives.

The care and upkeep and inspection of the electrics are matters of interest. They may be judged from the experience of the Boston and Maine on their Hoosac Tunnel electrification, where seven electrics are used. They never withdraw these locomotives from service for general overhauling; and, so far as I know, this is true with electrics generally. The Boston and Maine inspect their locomotives on the basis of every 1800 miles, when the main motors are blown out, brushes are replaced if necessary, clearances taken, switch groups overhauled, auxiliary motors overhauled and oiled, and other light repairs made. This is all.

The electrified terminal is an entirely different thing from the one operated with steam locomotives. Contrast the electrified terminals of New York, for instance, with the old style ones of Chicago. The steam-operated terminal is a nuisance. It is constantly crowded farther and farther from the center of business. But in New York

electrification makes it possible for great and elegant hotels and businesses of the highest and most exclusive class to exist right alongside a great terminal. There is little noise, no smoke or steam, no hooting of engines, no human suffering and destruction of property from soot and gases. Enormous values are added to property by this close proximity of fine business property to the very center of transportation. I should not be surprised to learn after Chicago's terminals have been electrified, that the cost of the change will be found added to the value of adjacent property.

WORTH THE PRICE

I have not stated half the case for electrification, but I think I have stated enough for present purposes. There is, of course, a case against it. For one thing, it would more completely integrate our transportation system, and render each part to an extent more dependent upon every other part. That is the price paid all through Nature for the higher development and the more complete organization. This penalty in the higher animal is death, instead of the everlasting life of bacteria. I can conceive an electrified transportation system completely paralyzed by the destruction of its power houses. But integration has already gone so far with the present railway system that it, too, staggers and falls down when it fails in one of its members. The peril through the complete integration by electrification is no greater. The paralysis of steam is on us. We must dare the remoter dangers of electrification, which can hardly come upon us except through the collapse of our civilization itself.

Electricity might be demanded in the place of steam even at increased cost of carriage, in a case of life and death; but we have no such choice to make. Electrified railroads can do the work more cheaply than steam railroads, even at the present price of coal, and with every rise in coal the advantages of electrification are increased. According to the annual report of the Norfolk and Western the cost of haulage by steam locomotive per million tractive miles is $29.90. The cost of doing the same work with the electric locomotive is $26.20. This is without any doubt an attractive saving.

No one suggests, however, that all the railroads should be electrified at once. No one can indicate what proportion should be electrified, or whether they should all ever be electrified. In any case it will take a considerable term of years to carry the plan out, no matter how soon it is undertaken. During this time the engines replaced by electrics would increase the power plant of the lines still under steam, and whenever there should develop a surplus of steam engines there ought, in a world short of locomotives, to be a market for them abroad.

The first electrifications should be on the mountain grades, where present facilities are inadequate, and in the dense industrial regions about our cities, and especially in New England, which suffers from lack of coal. The great superpower zone on which Mr. Murray has made a report should be included. This would give us electrification from Boston to Washington, through the great New England industrial belt, all around New York City, all of eastern Pennsylvania and New Jersey, Delaware, eastern Maryland with Baltimore, and the vicinity of Washington. But this is not enough for even the immediate future. The railways from this zone to Pittsburgh should be included at once. Also the electrification should be carried west through all the region between the Ohio and the Great Lakes, including southern Michigan. It should sweep up on

the west of Lake Michigan at least as far as Milwaukee, and across Illinois to the St. Louis trade basin. By that time the interests involved could tell how much further the work should be carried and how soon.

FUTURE FINANCING

"Yes," the intelligent reader has said long since, "but where is the money to come from? Electrification would have been carried on extensively long ago if things had not come to such a pass that money goes into almost any other business more freely than into railway investments." This is, without doubt, the great question. The project of making the railways able to save our business life is so large, no matter how it is done, that the financing of it is a problem as great as that which we met in financing the Great War. Do not ask what it will cost—nobody knows. The thing must be done, no matter what it costs, or the United States is a failure for the future.

It is, in fact, war—war to prevent industrial and agricultural ruin, east, west, north and south, war against continental distances, war against the very forces of Nature, a sort of war that no nation in the world's history has ever won. But see what we gain by winning it! And see what we escape by the victory! It is much more vital to our salvation than the victory over Germany. We could have existed and prospered if Germany had won; but America withers and dies when the railways fail. These recurring crises endanger the very fabric of society.

Once get this fact in the minds of the American people, once get it burned into their consciousness, and the money can be raised. Twice as much money can be raised unless America is busted. I do not believe that America is busted. A newspaper paragraph before me says it is significant that the word American ends in "I can." I like that quip. It tells the truth.

We may as well begin to think about ways to raise the money, for the railways in their present condition, no matter who is to blame for it, cannot raise it. It is a great public question, and not one for the railways alone. The railways might be conceived as each electrifying itself by its own efforts. That may be the better way. It seems to me, however, that the task is so great that it all should be done as one great job or it will not be done at all. This is as certain as anything can be, that the citizens of the United States must make up their minds to invest as freely in one way or another in the business of making our railway systems what they must be made as they invested in the winning of the war. Not that I mean that it will cost so much; but it will cost enough to make us all dig to raise the money. I have no idea how much it will cost, though I have seen estimates running to $20,000,000,000. It ought to be done in much the way it was done in war—under the spur of impending calamity. And it can be so done if the nation can be inspired to the task.

"There be three things," said Lord Bacon, "which make a nation great and prosperous: A fertile soil, busy workshops and easy conveyance of men and commodities from place to place." Every word of this is more vitally true now than when and where it was written; but unless we have easy conveyance of men and commodities from place to place we cannot have busy workshops and our fertile soil will by its very richness tempt people out upon it to their ruin.

The Influence of Cheap Power on Factory Location and on Farming

By Ernest S. Bradford
Economist-Statistician

WHILE it is always difficult to forecast the influence of a given industrial factor on the economic life of our people, it seems reasonable to believe that low-cost power will have a marked effect upon the concentration of manufacturing in cities, and upon the agricultural situation.

The location of industries in large cities has been due to a number of factors, among which are the desire of the manufacturer to make his goods close to his market and to have an adequate labor supply to draw from, and to have an assured and steady supply of power. Other factors, such as the desire to be near to raw materials, tending to draw him in a different direction, have been offset to some extent by cheap transportation, which has tended also to equalize distances from markets. Of recent years, however, there has been a tendency for new or expanding factories to locate in the smaller cities and towns as a means of getting away from the labor troubles common to the larger centers, providing employes with homes of their own and land enough for a yard or garden. This has been regarded as a stabilizing factor of some importance and a long list of manufacturers who have moved out of the cities is evidence of this belief. The trend away from the crowded metropolis where real estate values mount higher each year and living conditions become ever less comfortable, and more cramped, now promises to be given further impetus.

Why Not Go to the Villages?

When a power line makes electric current available at low cost anywhere along its hundred miles of connected poles and transformers, there is less reason to locate new plant construction within city limits. "Why should the factory stay in the city," says Henry Ford, for example, "when every increase in sales and manufacturing capacity sends higher site values needed for additions to plant, and makes it more and more difficult to find places where workmen may live in reasonable comfort?" Why not, therefore, go to the villages? Cheap power and cheap transport work together to this end. A motor truck on a hard road serves to bring in supplies and raw materials, and take away the finished products; and electric current at the door makes unnecessary the erection of a new boiler house and power house, or additions to coal storage facilities and unloading equipment.

The effect of cheap power, unless neutralized by forces to which we have not given consideration, is likely to add somewhat to the movement of factories away from the great cities and to change the map of our industrial power-using centers by adding to the number of small and medium-sized manufacturing cities and towns. The map (Figure I) shows the situation in 1920; it covers only users of power for *industrial* purposes.

The massing of population in urban centers, which is partly a result of the urban location of factories, will also be affected by cheap power. The latter will operate almost certainly as a force making for de-centralization. With the factories as they move to the country will naturally move also the workers who formerly clustered at the mill

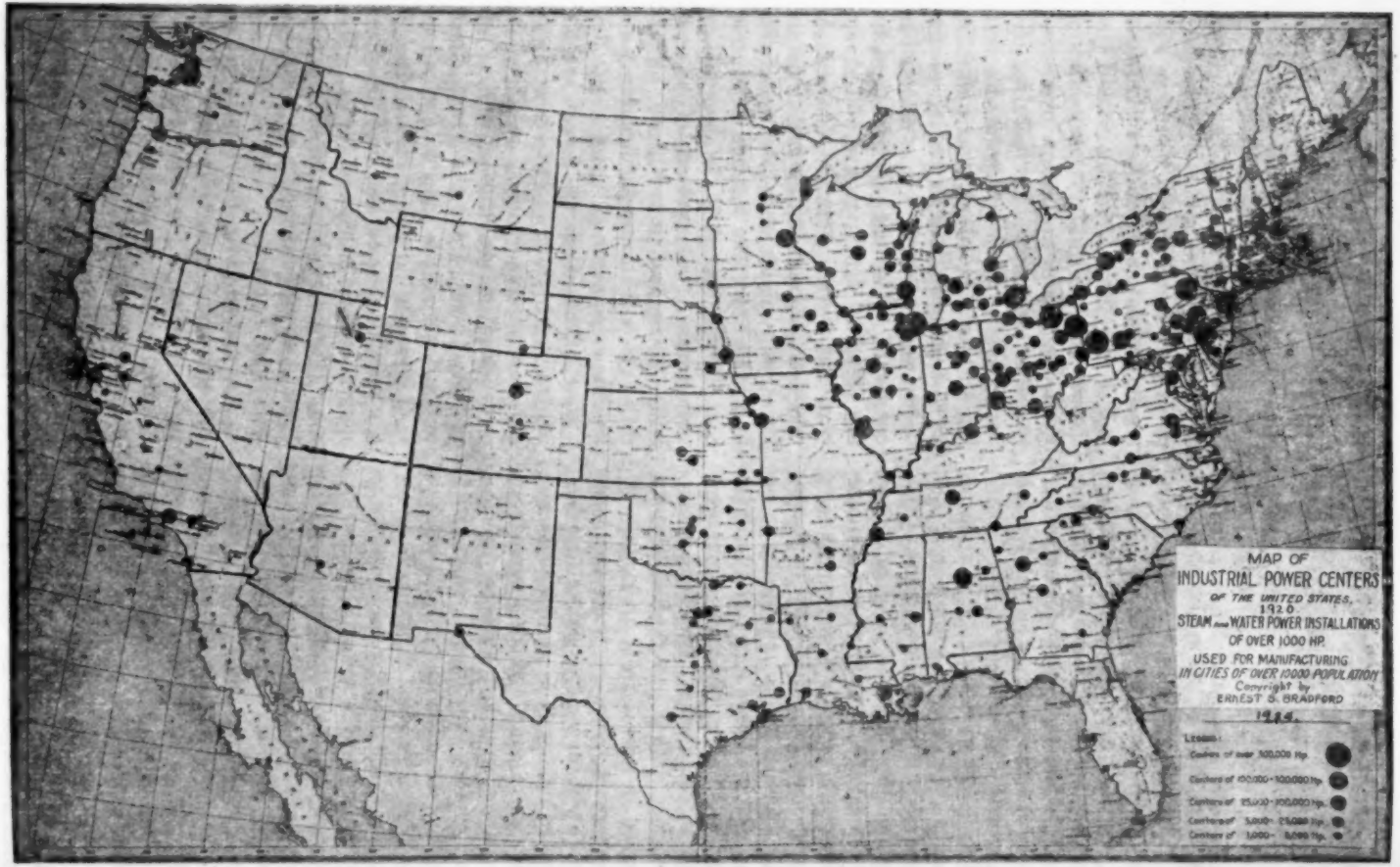
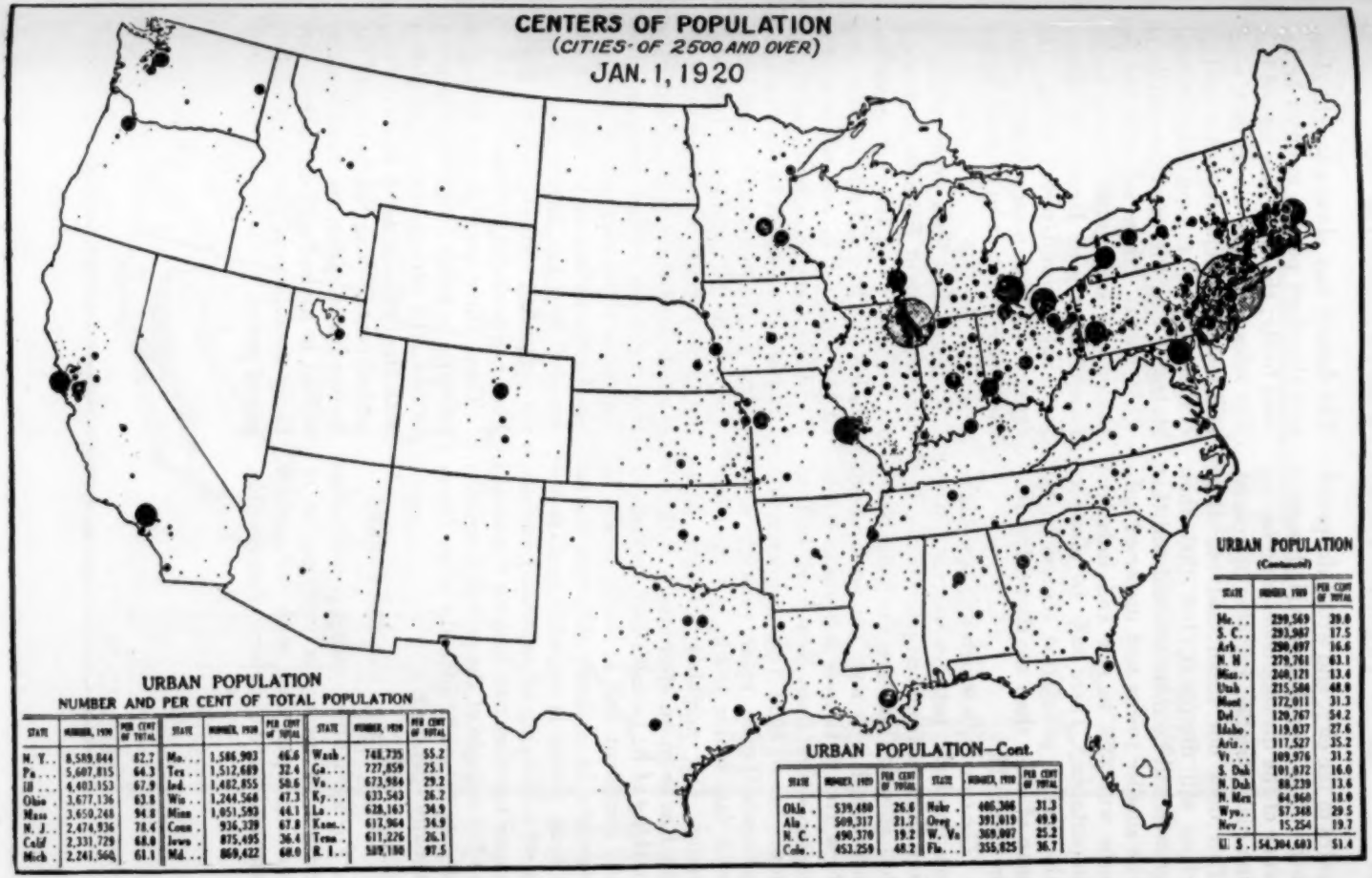


FIGURE I. INDUSTRIAL POWER CENTERS, 1920

CENTERS OF POPULATION

FIGURE I. INDUSTRIAL POWER CENTERS, 1920



URBAN POPULATION
NUMBER AND PER CENT OF TOTAL POPULATION

STATE	NUMBER, 1920	PER CENT OF TOTAL	STATE	NUMBER, 1920	PER CENT OF TOTAL	STATE	NUMBER, 1920	PER CENT OF TOTAL
N. Y.	8,589,844	82.7	Mo.	1,586,903	46.6	Wash.	748,735	55.2
Pa.	5,607,815	64.3	Tex.	1,512,689	32.4	Ga.	727,859	25.1
Ill.	4,403,353	67.9	Ind.	1,482,855	50.6	Va.	673,984	29.2
Ohio	3,677,136	63.8	Wis.	1,244,568	47.3	Ky.	633,543	26.2
Mass.	3,650,248	94.8	Minn.	1,051,593	44.1	La.	628,163	34.9
N. J.	2,474,936	78.4	Conn.	936,329	67.8	Kans.	617,964	34.9
Calif.	2,331,729	68.0	Iowa	875,495	36.4	Tenn.	611,226	26.1
Mich.	2,241,564	61.1	Md.	869,422	68.0	R. I.	589,180	97.5

URBAN POPULATION—Cont.

STATE	NUMBER, 1920	PER CENT OF TOTAL	STATE	NUMBER, 1920	PER CENT OF TOTAL
Okla.	539,480	26.6	Nebr.	486,366	31.3
Ala.	509,317	21.7	Oreg.	391,619	49.9
N. C.	490,370	19.2	W. Va.	369,007	25.2
Colo.	453,259	48.2	Fla.	355,825	36.7

URBAN POPULATION
(Continued)

STATE	NUMBER, 1920	PER CENT OF TOTAL
Me.	299,569	39.8
S. C.	293,987	17.5
Ark.	290,497	16.6
N. H.	279,761	63.1
Miss.	260,121	13.4
Utah	215,584	48.9
Mont.	172,011	31.3
Del.	129,767	54.2
Idaho	119,037	27.6
Ariz.	117,527	35.2
Vt.	109,976	31.2
S. Dak.	101,872	16.0
N. Dak.	88,239	13.6
N. Mex.	64,960	18.0
Wyo.	57,348	29.5
Nev.	15,254	19.7
U. S.	54,304,683	51.4

FIGURE II. CENTERS OF POPULATION. (*From U. S. Department of Agriculture*)

gates in the city, and with this spreading out of population will disappear some of the ills that come from having too many families per acre of ground. This does not mean that our large cities will disappear, but that their growth will be more gradual and that the smaller towns and dispersed suburbs will gain in size and industrial importance. There will be more of the smaller population centers on the map of cities than are shown for 1920 in Figure II.

The ease with which it is possible to communicate between distant points and to move from one place to another has shrunk this once far-flung continent until it is now not so far from New York to Denver as it was in Washington's time from New York to Boston. Since 1900 the shrinkage has proceeded even more rapidly, what with fast motor trucks, air mail and radio. Our neighbor drives a hundred miles in an afternoon and thinks nothing of it; he talks half way across the continent and at night listens to concerts in a dozen different states. Cheap power is an additional factor in this bringing of separated sections closer together and making it possible to live outside of the crowded centers; it goes naturally with the other forces already operating.

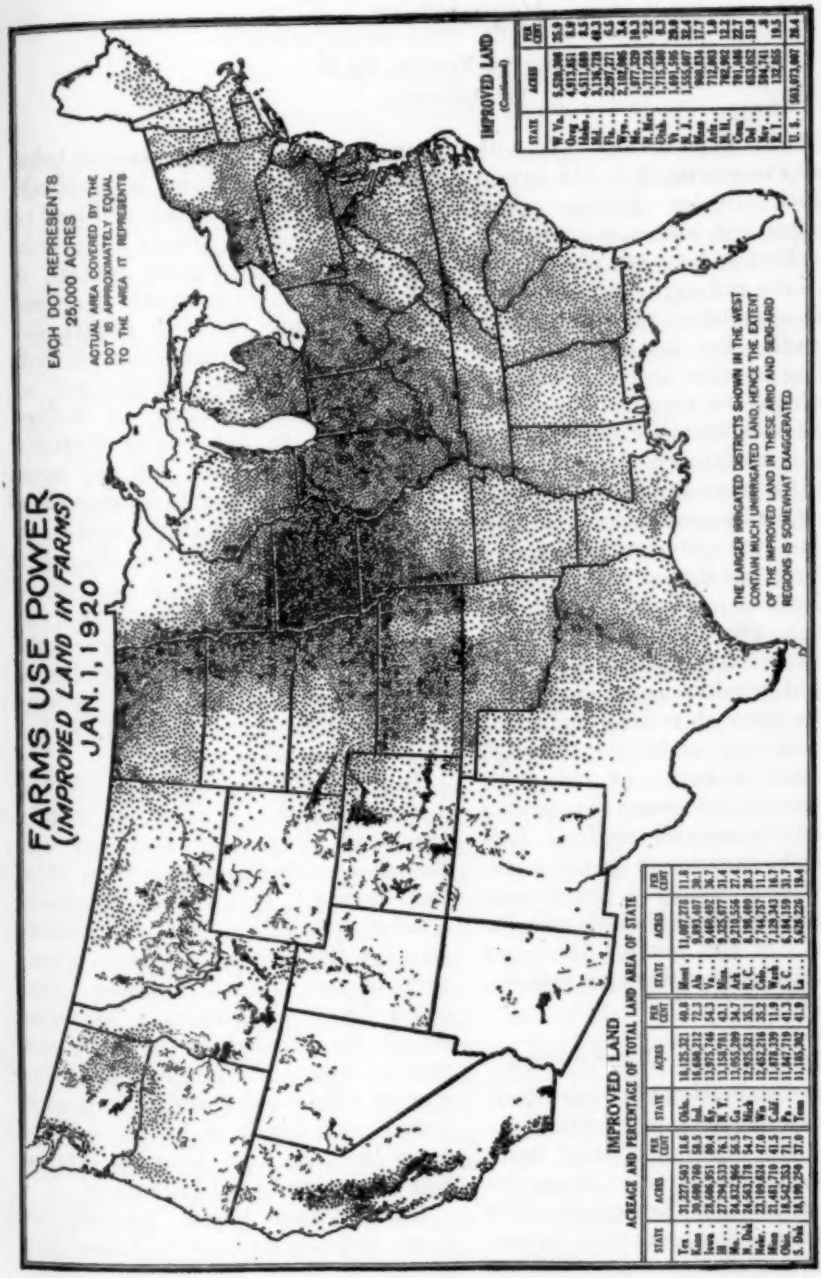
CHEAP POWER AND THE FARMER

For agriculture, cheap power seems certain to mean the carrying on of farming operations with far greater ease and speed than heretofore possible. The farmer has always sought cheap and abundant power; animals he has used freely; the wind has served him. The sales records of the largest windmill manufacturers show that the bulk of their output has gone to agricultural states and to the rural population of these states. More recently the gas engine and small water power installations have gone largely to operate farm lighting and power units. The farmer will use power freely, whenever he can get it at not-too-high a price.

Transmission lines from which he can take current for light and power for his barns and farming operations and his dwelling will add another item to the long list of conveniences—the telephone, the phonograph, the flivver, and the radio—which have come along to free him from his old-time isolation.

When the universal power line comes out to the farmer, it will find him more content to live on a farm, ten miles from a railway station, because he has mail from town, can talk to town, can run to town when he wishes, in a few minutes over the hard roads on the self-propelling wheels which Henry Ford has provided for him.

These three results—the freeing of factories to locate in suburb or country hamlet, the movement of population with the factories away from the congested centers and the freeing of the farmer further from the hard work involved in agricultural operations—are likely to follow in the wake of low-priced power.


FARMS USE POWER
(IMPROVED LAND IN FARMS)
JAN. 1, 1920
EACH DOT REPRESENTS
25,000 ACRES
ACTUAL AREA COVERED BY THE DOT IS APPROXIMATELY EQUAL TO THE AREA IT REPRESENTS
THE LARGER IRRIGATED DISTRICTS SHOWN IN THE WEST CONTAIN MUCH UNIRRIGATED LAND; HENCE THE EXTENT OF THE IMPROVED LAND IN THESE ARID AND SEMI-ARID REGIONS IS SOMEWHAT EXAGGERATED
IMPROVED LAND
ACREAGE AND PERCENTAGE OF TOTAL LAND AREA OF STATE
IMPROVED LAND (Continued)

STATE	ACRES	PER CENT
Tex.	31,227,583	18.6
Iowa	29,000,200	36.5
Ill.	27,794,333	78.4
Mo.	24,432,206	56.1
N. Dak.	24,463,178	54.7
Kans.	23,199,624	47.9
Minn.	21,481,710	41.5
Ohio	18,542,353	71.1
S. Dak.	18,199,258	37.0
Okla.	18,125,321	40.6
Ind.	16,600,212	72.3
Ky.	14,875,716	43.3
N. Y.	13,158,916	43.7
Ga.	13,055,209	34.7
Mich.	12,525,321	35.1
Wis.	12,452,216	35.2
Calif.	11,478,339	11.9
Pa.	11,347,719	41.3
Tenn.	11,185,302	41.9
Miss.	11,097,273	31.6
Ala.	9,693,407	28.1
Va.	9,469,477	30.4
Mont.	9,325,977	10.1
Ark.	9,210,556	27.4
N. C.	8,198,409	28.3
Colo.	7,744,257	11.7
Wash.	7,129,343	16.7
S. C.	6,194,159	31.7
La.	5,626,226	18.4
W. Va.	5,520,208	25.9
Oreg.	4,611,681	8.8
Idaho	4,171,680	8.3
Md.	3,134,721	43.5
Fla.	2,207,271	6.5
Wyo.	2,102,905	3.4
Me.	1,977,329	14.2
N. Mex.	1,717,224	2.2
Utah	1,715,580	4.3
Vt.	1,491,595	29.0
N. J.	1,355,697	32.4
Mass.	960,034	17.7
Ariz.	712,603	1.9
R. I.	782,982	73.3
Conn.	633,160	31.3
Nev.	394,741	.8
D. C.	132,455	10.5
U. S.	503,073,007	26.4

FIGURE III. WHERE THE FARMS ARE THAT REQUIRE POWER
From "A Graphic Summary of American Agriculture"

The Decentralization and Suburbanization of Population

By Irving Fisher, Ph.D.
Yale University

MACAULAY once said that with few exceptions, it is the inventions which abridge distance which have the greatest influence on human history. To the long list of such inventions—the railway, steamship, automobile, aeroplane, telegraph, telephone, radio, for instance—we are now adding another and one destined to be perhaps the most revolutionary of all, the long distance transmission of power, constituting Giant Power. The other distance-abridgers transport only goods, passengers and news. But now at last we can transport power cheaply and instantaneously. Power is the essence of productivity and productivity is the essence of income. Whether it be food-production through reaping and grinding grain, or shelter-production, through sawing and riveting, or clothing-production through spinning and weaving, or any other of the thousand processes for serving mankind with material comforts, it is power which, somewhere in the background, is ever pumping the income stream which floods our houses with the good things of this earth. Increased power means increased wages, salaries, rents and profits.

Effects of Power Distribution

A better distribution of power effects the same thing, and, in addition, relaxes the ties which now bind us to centers of power—factory steam engines, for instance. The essence of the factory system is a center of power, whether steam or water, and hitherto workmen have had to congregate around that center because the power could not easily be transmitted farther than the length of transmission belts. Now that basic condition is disappearing. Whether or not this will lead to decentralization or simply to a rearrangement of population centers, it will, in either case, mean increased freedom. Probably both results, decentralization and rearrangement, will follow. If it be true, as it may well be, that numerous workers in factory towns wish to get nearer Nature's open spaces, surely it will pay some enterprising employer to arrange some popular system of cottages and small workshops distributed in the open country or villages. If it be true, as it may well be, that many workers in factory towns would rather live nearer to, or in, the great cities, Giant Power may just as readily thread its way thither. Wherever mankind wishes to go, copper wires can go too.

In either case, the workmen will find a new freedom. If they feel unduly hampered where they are, they will find more options open to them than they do now. This will be a safeguard against exploitation, just as a generation ago the western workman, whenever he felt himself imposed upon, could bring his employer to terms simply by threatening to leave and take up land. The public domain was a great safety valve and as long as it lasted every free-born American could carry his head high, knowing that he had something to fall back upon.

Giant Power ought, partially at least, to bring us back to those days of independence by affording alternatives not now open. Probably the net effect will be a decentralization and suburbanization of our population.

Power and the Working Life

By Carter Goodrich
Department of Economics, University of Michigan

Of all the social changes that the innocent revolutionists of what we call *the* industrial revolution have brought down upon an unsuspecting society, none are sharper than those in the kind of life men lead during their working hours. It is the building of the modern factory in the place, say, of the "neighborly 'ten-footer' shop" in which the "fisherman-farmer-shoemakers" of the North Shore used to ply their "sociable handicraft," that is the most obvious mark of the movement. And few of its results are affecting the quality of modern civilization more intimately than those symbolized on the one hand by the sight of the craneman touching a few levers to do the tugging and hauling that has strained the backs of the pyramid-builders and their successors throughout the ages, and on the other hand by the "fascinating and horrible spectacle" of the jobs along the famous assembly line at Highland Park out of which the last residue of workmanlike interest has been relentlessly squeezed.

Yet these effects, like so many of the most important results of the revolution in technique, have been for the most part quite unintended. No one planned the tremendous increase in population or the swelling of cities; there has been almost as little planning to the end that the working life should be made more or less degrading or richer or poorer in human interest. For although the technicians have often pointed proudly to the elimination of rough and irksome labor, they have been able to claim it only as an "incidental" and sometimes as an "unsuspected" benefit; their main concern has been of necessity with other considerations. And so even more clearly for the other side of the picture; for whatever a strayed craftsman from Mars might suspect, we can be sure that no race of devils has been devising dull jobs for sheer delight in their dullness.

Will the Workers Benefit?

The fact is rather that the busy leaders of the older revolution have driven ahead toward their goals of production and profits with little thought of any of the social consequences and almost no thought of the effect on the quality of the working life. And so through the whole history of technical progress. Certain of the revolutionists of Giant Power, on the other hand, have conceived the far more revolutionary idea that a technical change can be guided and controlled not merely in terms of the need for more goods but rather in terms of social needs in general. They are asking, as this volume indicates, the very new question of how the innovations "can be made to contribute to the fulness of life." But a man's work is still a significant part of his life—and one that we have seen changing sharply with new technique; and those who believe that the differences between one job and another are important determiners of the quality of human living, are justified in asking that these more thoughtful revolutionists consider as part of their problem the question of how the new power will affect the fulness of life *on the job*. Will the types of

work under the new order offer to the ordinary man greater or lesser opportunities for dignity and ingenuity and self-expression? Will they bring to the workers more interesting jobs than they are now performing, or will they bring still duller ones?

These questions come with the greater urgency, moreover, because of some of the effects of past increases in industrial power and because of some of the claims that are made by the advocates of this one. Very often it has been just the fact of the cheapening of power that has made possible the substitution of repetitive for skilled and varied work; and certain power enthusiasts are boasting, though perhaps prematurely, that the complete elimination of the "unfortunate human element" from as good a craft as that of the locomotive engineers will be one of the first triumphs of the new revolution. The road of Giant Power is apparently the road of the more complete subordination of the individual to the machine's routine.

THE MENACE TO PERSONAL FREEDOM

But will not this very loss of individual freedom bring its own corrective? Will it not make the workers more determined and more successful in winning a different sort of freedom through the extension of their union organizations? And may not the opportunities for groups of workers to take a more responsible part in the running of industry make up, and more than make up, for the loss of interest in their special tasks? Very likely this is the more practical direction in which to look for the maintenance of the workers' dignity, and certainly such collective freedom becomes of greater importance to the student of the working life as the chances for self-expression on the job grow less and less.

But here again the past record suggests a much more ominous conclusion. Unionism tends to flourish, not where power and mechanization are the greatest, but where they are the least. It is the most thoroughly mechanized workers that are the least likely to be organized; and with hardly an important exception, the strongholds of the labor movement are to be found where the consumption of large-plant power is the least—in the hand trades, in the coal mines and on the railroads, and in certain factory industries that use considerably less than the average 3.2 horsepower per worker. And if the coming of Giant Power is to lead, as many believe, to a scattering of workers in smaller factories and in small towns, the change may add at least as much to the difficulty of union organization as it takes away from the need for it. So far, then, the indications seem to be that the great increase in power—whatever its advantages in other fields — will strengthen the tendencies that run counter to the chances either of individual or of collective freedom in industry.

It is of course possible that these tendencies may be checked. Perhaps some of the newer school of industrial engineers, in their search for a 100 per cent job to standardize, may find that the element of inherent interest is necessary even on grounds of efficiency. Possibly indeed the experiments of the author of *Non-Financial Incentives*—experiments made, by the way, in an industry that already uses more than 16 horsepower to the man—may mark the beginning of a return of work that will capture the imagination of the worker. And on the other side it is possible that the unions may meet the difficult problems of the change with new energy and new vision. The late President of the Federation of Labor had at least warned his followers not to let the "tremendous development" of Giant Power "roll its great weight"

upon an unprepared movement. The startling successes of the clothing workers, moreover, have cast a doubt upon the whole concept of "unorganizable" industries, and Mr. Gompers himself was facing the coming of the giant with at least the outline of a program for active union participation in the running of the power system itself. But in spite of all this, there is little evidence that the labor movement has either the strength or the definiteness of intention that would be necessary for a campaign that might bring a group freedom to the great mass of the workers in the power-using industries, and there is little doubt that the methods of Ford are conquering industry much more rapidly than the methods of Wolf.

THE CHALLENGE TO GIANT POWER

Without guidance, then, Giant Power appears to offer its great promises to society at the cost of a further narrowing of the range of freedom and interest in the working life. Here is a real challenge to the statesmanship of the new revolutionists. Can they give this consideration its proper weight along with the others as they plan the control of the change? Can they devise ways of bringing the benefits of cheap power without chaining the mass of the workers to repetitive machine-minding? Or can they so shrewdly strengthen the forces already working for freedom in industry that the dignity of the working life may be maintained whatever the nature of the jobs themselves? Perhaps these things are impossible. It may be that the new development cannot go on without the rigorous subordination of the individual during working hours, and it may well be that the promise of greater leisure and of a richer and fuller life outside the factory is sufficient to outweigh the loss in the quality of the life on the job. But those who "love liberty even in industry" may at least ask the revolutionists not to take this lessening in freedom too easily for granted. If they cannot avert it, let them count it as a real cost—to be recognized even in the chorus of praise for the blessings of the change—and let them at the very least make sure that those who are to bear this cost, and those who are to do these duller jobs, are to be among those who share most richly in the benefits of the new leisure.

Giant Power and National Defense

By Major General William Crozier, U. S. A.
Formerly Chief of Ordnance

THE World War brought to everyone's attention the indispensable importance of nitrates for war purposes.

Nitrogen forms part of the chemical composition of all practicable explosives, both of those whose comparatively slow combustion places them in the class of propelling powders, and of those with which the readjustment of the constituents into gaseous forms, upon explosion, is so quickly made as to give them a disruptive effect, and thus qualify them for use as the bursting charge of shell and other forms of bomb; for demolitions, and for general destructive purposes.

The propelling charge in a cannon of moderate size, being designed to be entirely consumed by the time it pushes the projectile from the bore, burns up in about the hundredth part of a second; and the consequent comparatively leisurely evolution of gas, as compared with the rate in a "high explosive," marks the difference between sending the projectile properly on its flight, and blowing the gun to pieces, as sometimes unfortunately happens when the bursting charge of the projectile gets prematurely detonated in the bore.

The peculiar characteristic of nitrogen, which gives it an exclusive kind of fitness to form a constituent of explosives, is its disposition to decline to remain in combination with any other substance, and to stand by itself: a substance of which it is a constituent can usually have the nitrogen shaken loose by the application of sudden heat, or by percussion, or by some other disturbance; and when the other constituents are such that the new combinations into which they are forced by the desertion of the nitrogen are gaseous, instead of the previously existing solid or liquid, we have an explosive; of which there are a number whose rate can be controlled in various ways, depending on the purpose.

But this very quality of aloofness in nitrogen, which forms its value as a constituent of explosives, also primarily renders it unmanageable and difficult to force into combination with other substances. There is plenty of free nitrogen to be had. The air is full of it, being four-fifths nitrogen, in mixture, not in combination, and it is not very difficult to separate it. But in this form it is already gaseous, and of no use as an explosive constituent which should be solid or liquid, so as to pack into a small space and be ready to expand into a large one. This difficulty of making nitrogen combine with other substances is so great that nature has not wasted much labor on it, and but few nitrates are found about the earth. In fact, the only natural deposits of sufficient magnitude to be of any real value are in Chile, and upon these the whole world has until recently been dependent for material out of which to make its explosives.

I say "until recently," because not very many years before the outbreak of the World War there had been developed to the practical stage three artificial processes of making nitrogen combine with other substances in solid or liquid form, so that it could be handled. Fixing it, they called it.

These were known as the "Arc process," the "Cyanimide process" and the "Haber process"; and upon them, and particularly upon the last, Germany relied for the manufacture of explosives of all kinds to enable her to continue the prosecution of the war, after her original accumulation of Chilean nitrates had been exhausted. Without these processes she would have been unable to keep on fighting, for the Allied control of the sea cut her off from the Chilean source of supply. Nitrogen is taken from the air, and no process fixes it at first with substances which will form a usable explosive. However, once fixed with a given substance, it is easier to pass it from one to another, thus combining it with the substances needed, than it is to fix it with the final ones to commence with. The arc process makes the nitrogen and the oxygen of the air combine chemically by passing them through an electric arc, and then to combine with moisture into nitric acid. This is used to manufacture many kinds of explosives. The process requires a large amount of electric current; and in time of peace is only practicable when power for the generation of current can be obtained very cheaply, as at advantageous water-power sites. In time of war its practicability depends on whether the power can be had at all.

The cyanimide process also requires a large amount of electric power, but only about one-fifth—per ton of nitrogen fixed—as much as the arc process. It first produces calcium carbide, well known in connection with acetylene gas, and fixes the nitrogen of the air with this in a substance called cyanimide, from which is made ammonium nitrate, itself a usable explosive, and then nitric acid, used in the manufacture of other explosives. The Haber process forces hydrogen and nitrogen to combine into ammonia by subjecting a mixture of them to great pressure, at a high temperature. The ammonia is then used to make nitric acid or other nitrates. The process does not require a particularly large amount of power, but it has been subject to difficulty through tendency of the apparatus to deteriorate. Nevertheless, Germany made much use of it during the war.

NITRATE SITUATION DURING WAR

When the World War broke out the subject of nitrates became an acute one for the military authorities of the United States, and especially for the Ordnance Department, which had the initial responsibility in the matter. A certain reserve store of Chilean nitrate had been accumulated—as much as Congress could be induced to make appropriations for—but it was not sufficient to be of much significance in view of the possible demand, should America be drawn into the war. At the request of the Ordnance Department, the Geological Survey made a search for nitrate deposits in the United States which might be practicable for use in war, although perhaps too expensive of development to compete with the Chilean supply in time of peace; but without success. None of the processes mentioned above for the fixation of atmospheric nitrogen had received any development in the United States, although there was a small cyanimide plant on the Canadian side of Niagara Falls, owned principally by an American company, and using its product for the manufacture of fertilizer. The situation was not so alarming as it might have been if the Allies had not had command of the sea, and if the route for nitrate vessels from Chile had not been comparatively safe from danger of German submarine attack. Also the case was

different from that preceding the War of 1812. Then, England was engaged in a desperate struggle with the power of continental Europe under Napoleon, and both sides were so intent upon injuring each other as to disregard the rights of neutrals, and inflict such harm on the commerce of the United States as to make it doubtful upon which side we might be drawn into the war. In the World War there was no doubt upon which side we would be, should we come in, nor did we face the possibility of the sea route from Chile coming into the possession of the enemy. We did, however, have to think of the ownership of the supply in the neutral country of Chile, where the Germans had a great interest; and we also had to think of the quantity which would be needed, and the means of transportation, both in South America and on the sea, with very limited shipping and haulage supplies for the nitrate regions. As a matter of fact, the transportation point became pressing soon after we entered the war, and it was made evident that an unprecedented quantity of explosives would be required for our own armies and to carry out the unavoidable program devolved upon us of supply for the Allies.

THE MUSCLE SHOALS PROJECT

In anticipation of the emergency, a year and a half before our entry into the war, the Chief of Ordnance had brought the necessity for a fixation plant to the attention of Congress, and Congress had ultimately responded by including in the National Defense Act, of June 3, 1916, an appropriation of $20, 000, 000 for the establishment of such a plant, the only sum carried by the Act, which was not an appropriation bill but one dealing with method and organization. The aid of the National Academy of Sciences was called in for advice as to the process to be adopted and the site to be chosen for the plant with the result that the location was made at Sheffield, in the vicinity of the Muscle Shoals of the Tennessee River, in Alabama, and a decision was reached to expend part of the funds for an experimental plant to employ a variation of the Haber process, which was expected to avoid some of the difficulties accompanying the use of very high pressures and temperatures. But, before a conclusion was put into effect as to the expenditure of the main portion of the funds, in the undeveloped state of American knowledge of the subject, we were in the war, and the considerations above sketched, especially the quantity of nitrate demanded and the scarcity of transportation, dictated the erection of a plant to employ a process which was not experimental—whether assuredly the best process or not.

In consequence, the cyanimide plant now at Muscle Shoals was built, at a cost of some $70,000,000, and with a capacity of 110,000 tons of ammonium nitrate per annum. This was known as Plant No. 2, and is the one of which the disposition is so much in the public eye today. Because of the time required for the development of the water power of the shoals, steam power was used, and the plant was completed, and successfully operated:—but just as the war came to an end. Its cost shows that it was not built from the funds appropriated in the National Defense Act, before cited. When its construction was forced we were in the stage which we promptly reach in all our wars, when money is made lavishly available in the effort to make up for previous stringency.

The anticipated need for nitrates was, however, so great that still further fixation capacity was considered necessary in a campaign of 1919 in

order to meet the expenditure of explosives; and two other plants, one at Toledo and one at Cincinnati, were commenced, at a projected cost of about $25,000,000 each. When the Armistice of November, 1918, brought the war to an end, these two projects were discontinued.

EXPANSION OF BY-PRODUCTS

This nitrate matter has been dwelt upon because the subject is closely connected with Giant Power, in that the most assured means for avoiding the dependence of the United States upon a foreign and distant source of supply for a commodity indispensable in war, viz., the cyanimide process of nitrogen fixation—requires a very considerable, though not an inordinate, use of electric current. It is the special province of Giant Power to augment this supply, and to so regulate its production and distribution as to make allocation to the imperative demands of war practicable and controllable, upon the emergency arising.

But this is not the only connection between Giant Power and explosive manufacture. The feature which relates to the generation of current by large units located in the vicinity of coal mines, and which contemplates the pretreatment of coal for the production of fuel for boiler plants, involves the evolution of ammonia as a by-product, and thus makes a direct contribution of an important nitrogen compound to the supply about which we are anxious. It is true that the contribution is not very great; but it is significant, especially as an accompaniment of the supply of current, which its availability at the same time diminishes the demand for. But there is still another connection between Giant Power and explosives.

I have thus far spoken of the nitrating element in explosive manufacture. On the same side of the reaction are the equally important substances to be nitrated. Of these the ones used in the largest quantities for war purposes are cellulose, potash, starch, phenol and toluol. Cellulose is nitrated into gun cotton, from which is made smokeless powder. Nitrate of potash—nitre—is the oxygen furnishing ingredient in the combustion of black powder; the original kind which served the world, practically exclusively, until near the end of the last century. Starch was nitrated in considerable quantities towards the end of the World War for use as the explosive charge for grenades and small shell. With none of these three substances to be nitrated is Giant Power especially concerned. But with phenol and toluol it has a very close relationship. Phenol—carbolic acid—is nitrated into picric acid, a high explosive furnished by us in large quantities for the French as a shell filler; and from picric acid is manufactured ammonium picrate, an explosive used by ourselves in the shell of the larger guns. Picric acid was also used very largely in the manufacture of chlorpicrin, an asphyxiating gas employed by the Chemical Warfare Service. The importance of picric acid can be appreciated from the increase of its production to about 11,000,000 pounds a month at the end of the war, from about 600,000 pounds a month a year earlier. From the other substance, toluol, is made trinitrotoluol, the familiar T. N. T. used so extensively in the war as a shell filler for our mobile artillery; both alone and in mixture with ammonium nitrate, as "amatol." The manufacture of T. N. T. was expanded from about 1,000,000 pounds a month when we came into the war to 16,000,000 pounds a month in November of 1918.

Both of these substances, phenol and toluol, are by-products of the pretreatment of coal for fuel. Phenol, or benzol from which it is synthetically derived, comes almost exclusively as such by-product; but toluol is had also from the distillation of wood, from the "cracking" of crude petroleum and some of its principal distillates, and from robbing ordinary illuminating gas of some of its heat and candle power. Contracts for the use of this last method were made by the Ordnance Department with the gas service companies of some fourteen of the principal cities of the United States during the war. In anticipation of the needs of the year 1919, the construction of plants was started so that the production of picric acid might be increased by over 40,000,000 pounds a month, and of T. N. T. by 6,000,000 pounds.

All this expansion was carried on under high pressure, and undoubtedly with much wastefulness. It is impossible to avoid pressure and wastefulness in carrying on war, but the feverishness of the pressure and the worst of the waste can be diminished by forethought, guided by a recognition of the possibility of war and by the expensive lessons of the past. No lesson of the World War has been more prominent than that modern war is waged by the industrial power of a nation. The country's great industries are therefore under the watchful eye of the General Staff, which undoubtedly realizes that if the Giant Power scheme can manage that portion of its program which covers the processing of coal for fuel, both for boiler plants and for internal combustion engines, it would seem to be possible to so select the process, and in plant construction to so provide for regulating it, as to give several of the by-products greatly needed in war, and some of them in very large quantities. Added to this is the advantage of including both nitrating substances and those to be nitrated, which last feature would diminish the draft on other industries made to complement the products of this one.

It is not profitable to attempt to estimate the relative value of indispensables; but among them are some that are more fundamental than others. That is, they underlie and have dependent upon them other necessities; so that, in giving attention to them, provision is being made for other things besides, and the foundation of preparedness is thus made broad as as well as solid. Such a basic indispensable in war is power; as made acutely evident in the late war. Under the tremendous orders for production which were given by the War Department, the Navy Department and the Shipping Board, complaints soon commenced to pour in of a shortage of power, and of damage to power equipment resulting from overstrain in the efforts to meet the demand. These complaints came from the the New England district, from the eastern Pennsylvania and New Jersey district and from the southern district; but they were perhaps most insistent and alarming from the great industrial district of western Pennsylvania and Ohio, centering about Pittsburg. Here was the very heart of the steel production of the country, and of its condition in regard to power it was stated in an interesting report by Colonel Keller, of the Corps of Engineers, on the power situation during the war, made in 1919, that the congestion of war orders and manufacturing had completely exhausted the power resources of the district, and that some of the central stations had gone so far in their effort to meet the demand that the breaking point had actually been reached, and serious

damage had been done to boilers and machinery, causing a material reduction in output. This at a time when the question of output was greatly worrying us all. The real power shortage in this district was found upon investigation to be at least 130,000 kilowatts in 1918, and the estimate was kept down to this figure only by careful restriction of war orders in order to avoid complete congestion.

MAKING THE MOST OF GIANT POWER

A survey of the general power conditions of the country, made in an effort to get the situation in hand, disclosed the fact that it was impossible to meet the shortage in the chief industrial centers of the United States by taking advantage of the diversity factor, and by shifting current from where it was less needed, and from where reserves existed, for the relief of these centers, because of the lack of proper connections between adjacent systems. Such alleviation as was possible was made where there was any interconnection, but it was altogether incomplete. And as to additions to the power supply, none of any magnitude was practicable because of the time required to build a large power plant, either steam or hydraulic.

After the war, and while the anxieties were still fresh in mind produced by the difficulties actually met and by the threat of greater trouble should the war last, as was expected, into 1919 or 1920, the Power Section of the War Industries Board prepared reports setting forth a general program which should be observed in order to avoid, in a similar emergency, the worst difficulties which had been encountered. A general conclusion of these reports was that the best economy and the highest national advantage would be served by the construction of large central stations of the steam superpower plant type, supplemented by the development of hydro-electric resources where these were locally possible and could economically contribute. This conclusion is in perfect accord with the Giant Power scheme. And the scheme also, by its emphasis on the feature of integration of the whole area to be served by the construction of strong transmission lines throughout its extent, would facilitate the shifting about of power from one centre to another, to meet the variation in demand which would necessarily arise when the fundamental object of industry should change its character from the strictly economic to the imperatively military.

The Giant Power scheme, as applied to Pennsylvania, accords also with another rule enunciated by the General Staff. It meets an important safety feature in the matter of location of great generating stations. The general rule to be followed whenever other controlling circumstances permit is that arsenals, storage depots and other important military establishments should be placed between the Appalachian and the Sierra Nevada or Coast Range mountains, and not less than 200 miles distant from the Canadian or Mexican frontier. Giant Power favors placing generating stations near the mine mouths, in order to avoid the haulage of low grade coal; and the wisdom of this course is evident, when it does not conflict with the cost of transmission of current over long distances to the place of use, or with requirements in the matter of condensing water for steam generating plants. The mine mouths are, generally speaking, in the safety area prescribed by the General Staff; and their distances from points of consumption of current in the area covered by the scheme are in no case beyond that of economical transmission at the high

voltage claimed to be entirely practicable by the great electric construction companies.

As to condensing water, the amount required for a given power is so incomparably greater than that of the coal consumed that there is no question as to which should be carried to the other, if this were the only choice. Unlimited supply of water is to be had only at the seaboard; and perhaps sufficient supply may sometimes be had only on the great rivers uncomfortably near the edge of the section which we are considering. But the last word has not yet been said as to the imperative necessity for condensing water for large steam power plants; and there is room both for computation of the relative economy of transporting coal to the seaboard as against the omission of the condensation of exhaust steam in special cases, and for consideration of other means of condensation than by water. Fortunately the sites for water power plants are generally approximately within the safety area laid down.

Giant Power is thus seen to offer prospects which are very attractive to the authorities responsible for safeguarding the military interests of the country. It is a lucky coincidence that this plan for the increase and the flexibility of power supply, which would be demanded in time of war for nitrogen fixation, should also offer an increase of the supply of fixed nitrogen itself; and it is in further degree lucky that the same plan should offer an augmented supply of the substances necessary to be nitrated. But perhaps most interesting of all is the fact that the plan should relate to the great fundamental need of power for war industries, and should be particularly concerned with the initial preparation for making the supply immediately and variously adaptable to change of demand. It is evident that the Ordnance Department and the Engineer Department will give heed to what is going on, and will have opinions on the location of plants and the selection of processes, which they may find means of inducing the promoters of the scheme to follow, in the interest of the government.

Financing the American Power Future

By Irving W. Bonbright
Bonbright & Company, Inc., New York City

How many theories and how many programs fall down before that pertinent and omnipresent inquiry "Where is all the money coming from?" The economics of a project is often the last phase to be discussed and yet it is always the first one which must be met. In the present instance it may be fairly met and readily answered.

There are two sources, presumably, from which capital for the extension of power and light service in the United States may be obtained—public funds and private investment. It is not pertinent to discuss here the comparative merits of municipal and private ownership. Experience has seemed to indicate, however, that privately owned and privately operated electric power and light companies have proved more successful and attained to a higher degree of service on the average than those controlled and managed through municipal operation. The private investor's dollar appears to go further than that of the state or of the nation.[1]

Assuming, therefore, that the preferable source to which to look for the capital necessary to finance the needs of the power and light industry during the coming decade, for the proper extension of its field of operations, is private rather than public funds, the first question is whether sufficient capital can be obtained from individual investors, and the first consideration of the industry is whether such investment may be properly protected. Capital may be attracted only if the security which is offered is ample.

Financial Solidarity

The history of the power and light industry from a financial standpoint fortunately shows a remarkable record of strength. In no other field of endeavor in this country has the financial record been more free from criticism than it has been in the power and light industry. Only our government bonds have shown fewer defaults than the bonds of this industry. Not even the railroads have in their senior obligations a finer record of which to boast. In the field of preferred stocks the power and light companies also stand pre-eminent. The results of a careful analysis of the dividend records of practically all electric power and light companies with gross earnings of $2,000,000 per year and upwards, the combined capitalization of which represents approximately 90 per cent of the industry, show that current cash dividends are being paid on all of the first preferred stocks; that in no case are there any accumulated back dividends unpaid; and that in all but 15 cases the stocks have unbroken dividend records.

This gives us some indication of the strength of the junior securities of the

[1] An adequate and factual discussion as to the relative merits of public and private ownership of electric service is necessarily beyond the limits of the volume. Without expressing assent to or dissent from this opinion of the author, the editor believes that the matter cannot be so simply stated. Any fairly conclusive answer to this largely political question possibly cannot be rendered in advance of such a searching, dispassionate and worldwide investigation of the outstanding successes and failures under both systems as has yet to be made.—Editor.

industry and affords striking evidence of the extraordinarily sound foundation of the senior obligations. The investor, accordingly, has come to expect unusual security in power and light issues and this is a very important factor in enabling the companies to raise funds at reasonable rates of interest.

There is no reason to believe that the needs of the industry during the coming years cannot be amply taken care of on the same basis as that upon which they now are met. The electrical industry has doubled during the past ten years and conservative estimates indicate that in the next ten it will again more than double if it is to keep pace with industrial and rural development. In other words, power and light companies must be ready each year to add to their capital investment 10 per cent of their present total. Assuming this total roughly to be $6,000,000,000, this calls for an annual investment of new capital to the amount of $600,000,000. That this may well be done at a reasonable rate of interest is altogether probable.

The confidence of the investor, as we have said, has already been won and this is a most valuable factor in the raising of new funds. There are three chief means by which the electric companies may raise money through the sale of securities: the first, bonds; the second, preferred stock; and the third, common stock.

METHODS OF RAISING MONEY

Taking these in order we find that there has been a material change during the last few years in the character of power and light company mortgage bond issues. The modern mortgage is "open end." This provides that from time to time additional bonds may be issued against new construction and come under the existing mortgage. This is in sharp contrast with the older method in which mortgages were closed and new money, when required, could be raised only by the issuance of junior securities. The terms of these "open-end" mortgages usually permit bonds to be issued for about 75 per cent of the cost of new construction, provided that the company has earned its bond interest twice during the preceding year. They also permit bonds to be issued par for par to retire underlying bonds. The rigor with which these provisions are adhered to gives the investor ample protection and accounts in large part for the fact that money may now be borrowed by well-established electric power and light companies on a first mortgage issue at a rate varying from 6 to 8 per cent net.

Another recent development of power and light financing has been the issuing of long term debenture bonds by certain companies having a high credit standing. This has had the effect of enabling the company to keep in its treasury a certain amount of its mortgage bonds which may have been issued against new construction and to sell debenture bonds in their place. The rate of interest which the company must pay upon these debentures is, it is true, slightly higher than it would be in the case of mortgage bonds. But the company considers this additional cost as an insurance premium, for the retention in its treasury of a certain amount of the company's senior securities, to be used at periods of financial stress for emergency financing, is a valuable protection. The advantage of these debentures over preferred stock (the issuance of which would have the same effect as far as the saving of mortgage bonds is concerned) is simply that the debentures, being a call on the earnings prior to the preferred stock, may be sold at a slightly lower rate of interest and consequently the cost of the "insurance premium" is correspondingly less.

The sale of preferred stock has netted power and light companies a tremendous volume of capital during the past two years, and the practice bids fair to increase in volume and value each year henceforward. During 1923 over $200,000,000 of preferred stocks of public utility companies were sold to customers and employes. This was a very decided increase over the previous year, and an idea of the growing importance of this phase of financing during the last few years may be seen from the fact that since 1914 the annual sales by this method, of shares of stock of a value of $100 a share, increased from 92,310 to 2,000,000 and in the same period the number of stockholders obtained by this method jumped from 4,044 to 280,000.

Of course the sale of preferred stock is not by any means confined to customer ownership campaigns. The splendid record of power and light preferreds has made this class of security attractive to many conservative investors and even institutional buying of the more seasoned issues is rapidly increasing.

Only a very small proportion of the capital requirements for additions and extensions can be derived from the sale of common stock. Common stock issues, however, are growing in popularity and it is not inconceivable that during the next decade actual financing may be done through this medium. Up to the present time there have been several instances of an exchange basis, common stock for preferred, being used as a method of retiring prior issues. There has also been one notable instance of common stock sold in a customer ownership campaign. This is particularly significant because it has been initiated by the very company that was the pioneer in the field of selling preferred stock directly to its customers and employes. It may very well be that in a few years this class of security can be sold to customers with a facility equal to that now enjoyed by companies selling senior stock issues.

FUTURE TREND

"The cost of money" to the power and light industry has been steadily lessening over the past ten years. It is estimated at the present time that the rate of interest on the borrowings of electric power and light companies of good credit standing varies from 6 to 9 per cent. This would include all marketing costs and incidental expenses of issuance. This is far below the figure that obtained some years ago when 15 per cent might have been the net average cost of raising funds by the aggregate issuance of bonds, preferred and common stocks. There is no reason to believe that this downward trend in the money market of the industry will not continue. The popularity of the issues of power and light companies seems to be well founded and there is no immediate prospect of any dimunition of it. In fact, there are movements on foot in several states to make the securities of the industry legal for the investment of trust funds and savings banks. It is logical that this should be done, for the element of risk in this type of investment is certainly no greater on the average than in the securities of railroads which are very generally approved as "legal." Resulting as this would in a considerably broader field for marketing power and light securities, it would naturally tend to increase their price and lower the rate of interest which the companies have to pay.

All this would appear to make it increasingly easy for the companies to raise funds for their extensions and improvements during the coming years. And at this point we may note the fact that these extensions and improvements will very probably be carried into the

field of rural electrification, which will ultimately result in an increased load and diversification of demand which should prove highly desirable. The power companies on the whole have a very farseeing outlook on the development of electricity in the United States and stand ready to contribute largely to this rural development. The system of interconnections, which has been developed and is rapidly being carried on under the generic term of "superpower" or "giant power," is making possible economies of operation which frequently act as inducements toward extension of lines in districts which may not prove immediately profitable fields of operation.

It is is an extremely valuable development of the industry from the standpoint of the country and is one of the significant and encouraging factors of the situation that the power and light companies are in a position to carry on this work from the investment of private capital rather than having the work left to be undertaken through public or municipal means. If the latter condition obtained, the resultant taxation might in many cases wreak a hardship on the community which would result in a net economic loss. Under existing conditions, however, we may confidently look forward to the rapid development of electric transmission to all corners of our country and the ultimate complete electrification of the United States on a basis both fair to the consumer and profitable to the companies.

The Place of Leisure in Life

By Joseph K. Hart
Associate Editor, *Survey*

IN an educational bulletin published by the schools of one of our largest cities, under date of December, 1924, the following statement appears:

The eight-hour day is now the accepted working day in almost all industries. That leaves eight hours in which people may follow their own pursuits. It is a matter of concern in a democracy what those pursuits shall be. If they are lawless, extravagant, harmful to health and morals, society as well as the individual suffers. In so far as these men and women make worthy use of their time the country will advance culturally, morally and socially as it has already advanced industrially.

Herein are expressed or implied certain fears that are typical of our common attitudes toward the extension of leisure time to larger groups of people, and which give adequate justification for a further examination of the whole subject.[1]

The Need for Leisure

The problem of leisure may be approached from at least three distinct points of view; in fact, it is so approached, either theoretically or in practice, by various individuals, groups and interests of the modern world. In the first place, leisure may be regarded as a concession to physical nature—necessary even in the case of an insensate machine—a time of recuperation—from work, for more work—a means by which the worker recovers from the wear of past toils and gets ready to turn to new toil. Looked at in this way, leisure has no value in itself: it has value only as it promotes later productivity. The measure of its value is the extent to which it promotes greater productivity; and the length of leisure to be allowed the worker, daily, weekly, yearly, must be determined by finding the amounts of leisure needed in each such period to assure the greatest cumulative productivity over the whole period under consideration. Any extension of leisure beyond these necessary amounts tends to raise serious social problems—as implied in the warning quoted above.

In the second place, leisure may be regarded as having absolute value—as being, in fact, the only distinctively human form of existence, offering, as it does, a sharp and pleasing contrast to the career of the slave who spends his life in the inescapably degrading activities of work. From this point of view, leisure tends to become a recognized career—the life of leisure—with membership in the "leisure class."

A third point of view assumes that leisure is an essential element in any well-rounded and complete living. It provides values that are indispensable and which can be secured by and through leisure alone; but these values cannot take the place of others, equally desirable, which can be secured through work activities alone. That is to say, leisure and work are alike indispensable to human living; each offers something

[1] In discussing the social possibilities of large scale electrical development under which dispensation power will be both cheap and plentiful, the view has been frequently encountered that the resulting leisure may easily have a bad influence on the race. Steinmetz, the great electrical engineer who died a few months ago, took these possibilities seriously enough to predict a two-hour working day and thereby drew down upon himself very severe criticism. We asked Dr. Hart to discuss this phase of Giant Power.—The Editor.

distinctive to every person; neither can be sacrificed by any one without loss; and neither can take the place of the other in any human program, either social or individual. A career which specializes heavily in either direction to the neglect of the other is imperfectly human.

The first two of these points of view, though seemingly antithetic, have definite relationships to each other. Primitive man was not afraid of leisure. He worked no more than was necessary. He did the things inescapably denominated in the bond of nature: he kept himself alive and as comfortable as possible. To be sure, primitive women worked more than a fair share of the time; but they seem not to have minded that so much as some of their modern defenders have tried to make out; and they gave to the world, as Mason has so clearly shown, and as if by way of compensation, more than their fair share of those peaceful and primitive arts which are still the essential basis of our civilization.

RISE OF THE LEISURE CLASS

But early in, or perhaps coincident with the rise of, what Veblen calls the "barbarian culture" (represented by all the great empires of history and, at its highest, by medieval Europe), invidious distinctions began to appear in the community. Certain individuals took over all the "nobler" activities such as war, government (*i.e.*, control), religion and sports; and to these individuals fittingly accrued, in due time, a monopoly of the leisure of the community: they became the "leisure class." To the remaining ones was permitted the toil by which the community lived with so much leisure as would enable them, by and large, to keep on with their tasks, just as they were allowed only so much food, warmth and shelter as would keep them thankfully alive. That is to say, in the development of social functions, one class accepted the care of all the leisure of the group with whatever responsibilities inhered in that care; the other took to itself the care for all the work of the group.

Now, it is obvious that this latter class must have some leisure; but it is also obvious that too much leisure would be dangerous. Workers must not recover too greatly, nor accumulate excess energy. They might begin to think about their lot; they might develop a sense of injustice; they might undertake some form of conspiracy; they might throw stones at the palace; they might come to think of leisure as their own by right, and foolishly and awkwardly undertake to force their way into permanent membership in the "leisure class." And, anyhow, Satan always finds some mischief for hands that have too much leisure to do.

A lumberman in the western woods expressed the matter concisely. He said:

> My workers used to be able to go to town once every six months and, in a week at most, get rid of their wages. Within ten days they were usually back on the job, happy and contented to work another six months in order to repeat the experience. But since the saloons were outlawed they can't get rid of their money so easily. Some of them are able to live three or four months on their savings. They waste all that time for me. They sit around cheap boarding houses, talk socialism, lose interest in work, build up feelings of personal injury and become general nuisances. I tell you, there's such a thing as having too much leisure.

THE FEAR CONCEPT

Moreover, a certain vague but very real fear appears at this point. Something of the aristocrat's ancient fear of the slave seems to menace us. The worker has inherited some of the at-

tributes and much of the psychological status of the slave. Booker T. Washington said once, speaking of the fact that the English in South Africa were afraid of the native blacks: "We are always afraid of those to whom we have been unjust!" The "barbarian" slave owner, down to our own slave-owning days, was always afraid of his slaves, and he treated them brutally at times—at times when he was most afraid! "The uprising of the working classes!" Does not that phrase conjure up many of the ancient terrors which our ancestors felt when slaves or serfs attempted to take over the control of their own lives—with none too gentle hands? Is it strange, therefore, that we should almost universally assume that, if workers secure an extension of leisure time, they will use it "lawlessly, extravagantly, with harm to health and morals?"

RELATING LEISURE AND WORK

In sharp distinction to this fearfulness appears the suggestion that, for some of us, at least, leisure has, and should have, absolute value. "Man—(that is, of course, some men!)—man was not made," say these, "to be the slave of necessity. He was made to be free. He truly lives only when he is free—free, that is, from all the degrading forces of nature—free from work—free to devote himself to whatsoever he may freely and deliberately choose to enjoy or to use!"

Such leisure is, of course, not for all men, but for those, only, who are able to use it in a civilized fashion. In so far as this conception of the possession and use of an absolute leisure exists, it is mostly a survival from the invidious class distinctions of ancient and medieval times. Our age seems not wholly decided as to its attitude toward these matters, however. With some, leisure tends still to be a career. This does not mean that the members of such a "leisure class" never do anything. Their days, even their moments, are filled to overflowing with appropriate and "terribly wearing" activities. But these are always, or nearly always, activities that seem to have reached a status of their own: sports, charities—of a sort, patronage of the arts, and the like. It is held by some that this "leisure class" is the chief defense of our somewhat precariously existing "culture." Others, however, feel that this "leisure class" is primarily the conservator of irrelevant forms of old culture, the instigator of decadent forms of new culture, and one of the chief obstacles to the development of a genuine and indigenous culture of our own. There is, here, the making of a very pretty quarrel in which our academicians, our idlers, our technicians and our workers will all, eventually, find themselves involved—not to say, lost.

But it must be apparent that neither of these two old views can really satisfy either the social spirit or the scientific temper of our age. We need a third approach to all these problems, both of leisure and of work. No man can live by work alone: he becomes a slave to routine and loses his humanity. No man can live by leisure alone: he becomes a slave to the search for diversions, or stagnates in the moral vacuum of a social caste, and dissipates his humanity. Human experience may be infinitely rich and varied—in a world that provides a rich and varied range of expressions and satisfactions. Work and leisure—busy-ness and idleness—are two indispensable elements of such a world. Without something of each of these no individual or social group ever achieves full growth.

Our modern centralized civilization has, in some measure, begun to escape from both these older views as to leisure and work. We have no great patience

with either the worker who grinds his life out in a dull routine or with the social fool who tries to spend his life in a stupid round of idling. But we have not yet faced the great task of redistributing our work and our leisure so that we shall all get a sane share of each. Rather we have tended to dehumanize and standardize both our work and our leisure so that few of us get any permanent satisfactions from either. Work has become "business": we are caught in the machine, we make so many revolutions in so many hours, and "call it a day." Leisure has become "vacation," "a holiday," "time off": we escape from the machine so many hours each day, so many days each week or year—but with the definite understanding that we have not really escaped at all: we have merely been allowed a "temporary release, by concession: all rights reserved to the machine!" We even tend to make "events" out of our vacations, so that the grip of the machine and the impact of "business" are not wholly escaped even in our "time off."

None the less, in certain respects, these are movements in the right direction. Our social living must become inclusive enough to hold both work and leisure for all, and a genuine *modus vivendi* must be established between them. Most of our ancient institutional arrangements, our cultural attitudes and our folkway prejudices are opposed to such a *rapprochement*. Our old gross forms of work fear culture as being effeminate, or worse; culture fears work as being vulgar and unsympathetic. But one can discern tendencies which indicate that work is either going to capture the values of the older culture, or else make a new culture after its own patterns and nearer to its heart's desire.

To be sure, some of our so-called modern science seems set to prove that some considerable part of our human race is not fit, and not to be fitted, for any such full membership in humanity. This may turn out to be the case; but, if so, it will also appear in due time that this incapable fringe of mankind comes not all from any one of our former social strata, but is made up of individuals from all classes, notable instances of it coming from amongst the idle rich who have never known any of the effective disciplines of life, have little real sense of the meanings of existence and, hence, have no capacity to use life or time profitably either for themselves or for the community.

HUMANITY AND GIANT POWER

The cure for the evils of a centralized and machine-made age would seem to lie in the re-discovery of the human community; not the old community of invidious distinctions, but a new community, wrought of our social spirit and our scientific temper. Such a community seems to be promised in the age of Giant Power. Humanity seems to be moving, partly by revulsion, partly by attraction, toward a smaller, decentralized community, within which, without loss of industrial efficiency, life can escape somewhat from the monstrous machineries of the age of steam, and men can once more assume some measure of control over the conditions of their own individual and social living. It may even be that we shall have learned enough through our experience in cities, in the past century, to bring to the organization of life in the new industrial age a degree of critical intelligence and a sense of the joy of living never dreamed before.

If so, we shall probably undertake to escape, slowly but surely, and eventually completely, from those old false antitheses between action and leisure, between work and culture, between the hand and the mind. We shall make a

community in which action and leisure will both be at home with every individual; in which culture will have some integral relationships to work, in which the hand and the brain will "go ever paired." Doubtless it will take education—of us all—to produce such a community and such an age. But when once such an ideal grips us we shall find much joy in working for it. And we shall then be able to escape from those degrading folkway fears, dating from the servile ages, which make us warn ourselves and one another against the dangers of extending leisure to the masses of men.

Aesthetic Considerations Affecting Power Development

By E. H. Bennett
Consulting Architect, Chicago Plan Commission

AESTHETIC considerations affecting the development of power in the state of Pennsylvania, or for that matter in any other part of the country, is a large and rather difficult subject. It is only possible in this article to make a hasty review in the hope of attracting further thought and attention to it.

There is a general growing recognition by a portion of the public—or should we say by the more enlightened public—of the defacement of the countryside as well as of our cities by every form of utility development; and this includes as large factors, the harm done by power, light and other lines using the old clumsy overburdened wooden poles carrying all kinds of overhead wires, and that done by poorly placed if not poorly designed power plants and substations. In this latter field it becomes evident that unless checked, the damage done in the future will be even greater than in the past, due to the thoroughgoing plans for power development projected in the country.

It is fair, however, to say that considerable enlightenment is being shown by those who are responsible for power development, the power companies in certain states, where considerable attention is being paid to landscape treatment around power plants. This is also happily evidenced by the action of the director of the Giant Power Survey of Pennsylvania in asking a committee of the American Institute of Architects to make suggestions in this respect.

Dangers of Defacement

To the Landscape. The dangers of defacement of the country lie not only along the highways but also in the broad countryside. It has been the common practice when a high voltage transmission line is run through the country that its course has been studied neither from the point of view of the contour of the region nor presence in its way of fine country or forested land. The trees are often ruthlessly cut down in the cross-country run or are slashed and trimmed without any regard to their natural beauty, just as they have been on the highways. Again, the natural growth near the towers is damaged by the work of installation of towers and poles.

In a hilly country the objections to the straight lines of poles running on the shortest distance between two points considered, and passing without regard to the contours up and down hill, would lead one to plead for at least sufficient modification of the direct line to conform its general route in some extent to the contours of the hills.

The cuttings through the forest are not necessarily always objectionable. They have a practical advantage with respect to firebreaks. Not only that but they create, if well carried out, the vistas for which the great parks and forested lands in France are noted, often revealing glimpses of country which otherwise would be unseen. They should be, however, associated with highways or transportation lines.

The imperfect location of transmission lines (and in this connection the term is used generally for all forms of power lines and poles) results in part from a lack of a complete and studied system of highways, trunk roads and

transportation lines with which in one case or the other the power or other lines might be associated and very properly should be, the distributing lines on the highways and the high voltage transmission lines preferably along or parallel to the railroads or other lines of transportation.

The regrettably neglected appearance of many of our highways is accentuated by the multiplicity of utilities—power, telephone, telegraph, and even trolley service—for the most part the wires all carried on separate systems of poles. The pole lines should be consolidated as much as possible, as is being done to some extent with lighting and trolley poles in large cities. In the past the average American city, both large and small, has in truth been rendered hideous by poles of every kind. Poorly designed, overburdened and of blackened wood and iron, they create the most depressing effect possible. It is true that the growth of the country and of the cities has been too rapid for us to keep up with, in view of the enormous territory and distances in the United States. It is time, however, that these things were changed, and now in Pennsylvania through the Giant Power Survey it will be possible to form a judgment of what the future has in store for power development and what must be provided in the way of transmission and other lines. It will soon be possible to arrange a program and to attempt to correlate the necessary services and to simplify their physical expression.

Undoubtedly this should be done in connection with a restudied highway system especially in the environs of our great cities.

Curiously enough the damage to the countryside is equally possible in both types of country, the flat and the hilly. It may be argued that in the latter there is more to spoil with respect to the hillsides and the streams of water. But quite often the power houses and substations may be hidden from general view except at close range when located in the spurs of the hills, if advantage is sought of such opportunities. Again, the pole lines will be seen only from time to time in broken country. On the other hand, in flat country the uninterrupted run of poles is more inevitable. The unbroken continuity of these lines is perhaps the worst feature. A maxim used by a noted French architect, "a motif even bad often repeated always looks well," is true only in this case when all is seen at a great distance. In land devoid of trees, these pole lines are especially noticeable, as is illustrated in the bottom lands of California in the long stretches from the mountains to the shore.

Here something of a parallel exists between these lines of poles and the lines of trees originally planted in solid rows along the highways or surrounding the great cultivated fields to which they serve as windbreaks. The country, in many places originally bare as a desert, was relieved from its flatness by these trees, and the whole aspect of it has been changed since cultivation began. Unfortunately the same thing cannot be argued for transmission pole lines because of their thin outlines in the distance and ragged appearance near to; also, although in many places equally visible as the trees, they sprawl in all directions. The obvious reflection is that they should be massed with the lines of the trees and associated with them in the landscape effect when seen in the distance and screened by them when close at hand.

As has been pointed out above, the massing of the pole lines with planting on the great highways removes largely the objection to them, as a necessary

service. The same appears to be true of the great transmission tower lines which if properly placed would have such support, æsthetically speaking, as to remove their stark appearance in lowlands or to give them a grandeur even on the hillsides. To a mind of any imagination there is at times something irresistibly fine in the aspect of great airy structures stalking the hills. But this impression can be lasting only when their course is justified by apparent good arrangement with respect to topography.

To the Highways. Perhaps the one thing most commonly objected to is the defacing of our country highways. Any highway may be ruined by interminable lines of poles of poor design, especially when they are placed in front of or in line with the street trees so that the latter are made to suffer on this account. This is often not the fault of the power companies. It results very largely from lack of attention to the design of the highways themselves. Adequate room is not left for the utilities, not even enough at times for lighting standards. It must be recognized that ample width should be established in these thoroughfares as well as in our streets to provide for roadways, walks and all other utilities.

The European practice with respect to poles is better than our own, but their program has been smaller, especially in the past. One sees very good designs of coupled wooden poles bound together with interesting wrought iron ties or web concrete poles or finely designed web metal.

Possibly it is fair to throw the greater responsibility for the most objectionable features under consideration on a public, which through lack of education demands nothing better, for there are now other forms of ugliness invading our highways, such as crude lunch places, oil stations, refreshment stands, barnlike dancing pavilions, and advertisements, all as a result of motor traffic brought into being as the motor makes it possible for all to go out en masse to the country.

ÆSTHETIC CONSIDERATIONS

A plea for æsthetic consideration among us usually is mistrusted—it seems an impractical one. It is only when pleas have been unheeded and violations have accumulated for years that the full force of the neglect is seen. Often enough this mistrust of the attempt to make more beautiful our utilities is entirely misplaced. Great improvements of many types of equipment may be made which will not add to the expense of the equipment; good design is just as practical and perhaps more so than the so-called practical designs of construction ofttimes more extravagant of labor and materials than a fine design of the same structure. This is evidenced in a steel structure by a simple change, the introduction of curves in the gusset plates, otherwise angular, which often changes its entire appearance.

The most important consideration, of course, is the relation of the elements of a structure and the substitution of a greater number of smaller members for clumsy parts, and generally a careful study of the total effect of the design; an observation as far as design is concerned applicable not only to towers and transmission poles but also to the various structures, power plants and substations.

Color again is a matter of importance as also is tone, black and white values. The greenish gray of the garden trellis is much used in France even in utilities such as iron lattice construction. Its appearance on the landscape is vastly more agreeable than the black of the average pole to be seen in our lines.

Apparently it is well, whether well

designed or not, that these utilitarian structures should not be seen in their entirety. They must to some extent be disguised or revealed only in part. It is a matter of observation to the author that under these circumstances the chief objection to them may be removed. The screening by trees, clipped hedges, the ordinary shrub, or whatever may be adaptable or suited to the particular situation, will all play a useful part in this connection.

When all is said, however, we are finally brought back to the controlling consideration of location and general arrangement. It may be too much to expect at present universally good architectural design for power plants or transmission towers and poles. But a vast improvement may be made by their proper placing, and ofttimes the landscape rendered more interesting because of their presence.

All these utilities should be given as orderly an arrangement as it is possible. No plea is made here for the constructed picturesque; given time, nature will accomplish that. The chief care here must be proportion, suitability and order.

What is Giant Power For?

By Martha Bensley Bruère
Associate Editor, *Survey Graphic*

THERE is no other way to measure its value than by what it is for—by what it does to the lives of those who use it. Like opium, fresh air, alcohol, exercise and education, it can be judged by its works. There is no other just measure; neither cost, method of production, form of ownership or resulting monetary profit is important in itself. Only what it does to you and me and little Mary Jones really counts. And it is possible to judge Giant Power by what it can do, by studying the spots where it has already done it!

Last summer in Prague, a charming and distinguished Czech lady[1] asked Mr. Morris Cooke: "What is the most effective way of driving a wedge between the women in Czechoslovakia and drudgery?"

Apparently he answered her in terms of Giant Power, and since she was a member of the City Council, with a woman's practical wish to get something done *now*, she put the matter up to the directors of the electricity supply within twenty-four hours. For to drive a wedge between women and drudgery is exactly what Giant Power has already begun to do.

The Wedge

I was motoring across the province of Ontario last year when I came to a pretty house of yellowing brick, standing where one long smooth concrete road crossed another long smooth concrete road like the white markings on a tennis court. It was the house of a country doctor and the only other house in sight was that of the doctor's son, who was running the surrounding farm which the doctor had inherited but did not care to work. It was eleven o'clock in the morning—a busy hour for a country woman—but I ventured in.

Silence and peace pervaded that immaculate place and the doctor's wife had been reading a magazine. Her low chair by the window was still rocking when I went in. At my concern at interrupting her she wondered a little. Why shouldn't she be interrupted? She wasn't busy! Then she took me on a sight-seeing tour through her house. After that we sat down and I set on paper just what she actually had to do in that part of her job which was running a house.

In the morning she turned on the current in the hot water heater so that there would be hot water for baths. By the time the doctor was ready for his, she was dressed and had the coffee percolator going and the toaster ready. The cereal had spent the night in the fireless cooker. After breakfast, if it was wash day she started the electric washing machine in which the clothes had been all night. Then she washed the dishes,—she had never found any way to "do" dishes or "make" beds except by hand! Usually she ironed all the clothes except the "flat work" before dinner, which was at one o'clock,—doctor liked it in the middle of the day if he could get home. Why not the "flat work?" Because the mangle worked better with two people at it,

[1] Madame Françoise Plaminkova, President of the National Council of Women, of the Republic of Czechoslovakia.

one to feed the things in and one to take them out, and her daughter-in-law, who didn't have one, brought her sheets and things over the next day and they did them together. Dinner? Of course she had to get every thing ready. vegetables and desserts, just as she always had, but her stove had a time clock and when things were once in it she hadn't any more to do till it was time to take them out. Oh, no, there wasn't any special sweeping day. She just used the vacuum cleaner when she thought the house needed it. What she really wanted was one of those new electric ice boxes! Did I know the best kind? She wished she could see Sir Adam Beck[2] himself, he'd probably be able to tell her which make she ought to get. How much time did it take her? She hesitated to guess, wasn't used to figuring it out that way, but certainly not more than three or four hours a day, unless the furnace was running when, in spite of the thermostat, she had to put coal on about noon—doctor tended to it night and morning. Hard work? Drudgery? Why, no! Nothing that she even disliked except making blanc mange—and doctor was *so* fond of that!

Could a housewife be further separated from drudgery than that? Her daughter-in-law was not quite so free because there were the added duties of a farmer's wife and two small children, but there was no real toil for her either. Both these women had been freed by the fact that plenty of electric power was available at their doors and that it cost them only about 3 cents a kilowatt hour. For them leisure and ease were not only possible but cheap.

[2] Chairman of the Hydro-Electric Commission of Ontario with headquarters at Toronto, Ontario, Canada.

I have the results of a survey of one of the rich dairy counties of Wisconsin in which 42 farm families use electricity at a rate which is more than a cent above that of my Ontario doctor's wife, but still cheap. More than half of them must be as free from household drudgery as she is, judging from their equipment and the use they make of it. The horror of wash day must be vanished, for more than half of them have electric washing machines while all of them have electric flat irons—some more than one—though the mangle for "flat work" has not arrived. The woman carrying the coal hod must be a vanishing figure, and building up the kitchen fire before dawn an obsolescent activity, for more than half of them have electric ranges and 78 per cent either hot plates, toasters, coffee percolators or grills. And where more than half of the women own vacuum cleaners how small the sale of brooms must be! Bathroom heaters, curling irons, sewing machines and fans, these farmer's wives in Wisconsin seem to have if they wish. For them, too, the possibility of leisure and free time has come.

In the Northwest, where the potential hydro-electricity is said to be about six times the amount needed for another decade, there are already large electrified sections where no woman does household drudgery except by choice or ignorance, and the same thing is true throughout the great Sacramento and San Joaquin valleys of California.

The wedge can be driven between the farmer's wife and drudgery because it has actually been done! And if it can be done for her, it is far easier to do it for the women of the small town and the city.

But freedom from drudgery is only the beginning of the matter. It is

not leisure in itself that women are seeking, but opportunity. Can Giant Power help them to this?

WHAT GIANT POWER COULD DO

In a region of New York state that I know well, electricity costs 14 cents a kilowatt hour and coal from twelve to seventeen dollars a ton, according to the kind and quality. The principal town has several small industries in which women might find work. There are three laundries, a mattress-maker's shop, two restaurants, an infants' wear factory, two banks, a job printer's establishment, the office of an electric company, a telephone exchange, a high school and a silk mill which present possibilities. But the banks, the printer and the electric company employ women only as clerks and typists. The mattress-maker operates only intermittently, the infants' wear factory has been beaten out by metropolitan competition, and the silk mill which depends on water power can only operate when the streams are full. In the stores along the main street, the laundries, the restaurants, the telephone exchange and the high school, the quota of possible employes seems to be full. That normal crop of girl babies appearing every year has a good chance of health, happiness and education, but small opportunity for any but an unskilled job. They can always get a chance to do cleaning and housework, either by marriage or employment, but it is about all they can count on. In practice they follow the promise of opportunity and go to New York City. And there they help to complicate the housing situation and the employment situation and the recreation situation and the transportation situation and all the other situations that make city life difficult.

Why must they go? Because in their home region there is no adequate power to run industries which might employ them. Coal is too expensive, water power too uncertain and electricity prohibitively costly.

I visited a town of about the same size where electricity—all that one could want for all purposes except to heat their houses in midwinter—is to be had at rates which make it as advantageous to establish industries there as it is in a large city. As a matter of fact, there are twenty-eight industrial plants in that town more than half of which employ women, and all twenty-eight seem to be flourishing and must therefore be able to compete with those in larger places. It is not located in nearly so lovely a region as that of my New York state town. Instead of being set high on the hills above the Hudson, it is in the midst of a flat, brown, farming district. As beautiful places in which to live, there is no comparison between the two spots. But the second town is in Ontario and cheap electricity has given its women not only freedom from drudgery and leisure and ease, but opportunity as well. With us drudgery survives because electricity is excessively *dear*.

That Giant Power should free women from household drudgery and give them leisure, is a perfectly simple proposition, the feasibility of which has been demonstrated. That Giant Power can remove the industrial differential against the small town and make it as profitable to run manufactories there as in the cities has also been proved.

One phase of the problem, however, has not by any means been solved, though it results directly from the application of electricity to the home. The woman whose home work has been reduced to three or four hours a day is not satisfied by that pleasing

fact. An empty leisure satisfies her no more than an empty purse. Neither can it in the long run satisfy society, which cannot afford to carry any large proportion of its population indefinitely on a half-time production basis. The half-time leisure which electricity creates must be filled with the half-time job. It is all part of the same problem.

There is of course no intrinsic reason why the factory system, for instance, should not be as well organized on a basis of four-hour shifts as of eight-hour or twelve-hour work,—except the cogent one that it has been done only in a few experimental cases. Highly skilled and specialized work may be difficult to readjust in that way, but there is no reason why the tending of modern machinery with its maximum of mechanical efficiency and its minimum of human control may not pass from one feminine hand to another at the noon hour without slipping a cog. From the woman's standpoint, one of the objections to a four-hour factory day would be the time it would take her to get to and from work if she had to go to some remote industrial city to do it, but with electricity bringing the factory to the town in which she lives, that part of the difficulty at least disappears. This whole adjustment of the varying lengths of the work day that electricity in the home makes necessary, is a job for the engineer. But it ought not to be any more difficult for him than that problem set for children in kindergarten,—putting the "Sixth Gift" together. This "gift" consists of fifty-six wooden blocks each one of which is some part of a cube. There are half cubes and quarter cubes, cubes-and-a-half and double cubes, cubes cut on the bias and cubes cut on the straight. But properly combined they make the equivalent of twenty-seven one-inch cubes and will combine into one three-inch block. The quarter days, half days, whole days that women can give can be measured out into full eight-hour days and combined into the whole factory system. That is, if we realize that social and industrial efficiency may be the same thing.

Charlotte Perkins Gilman has a poem beginning

Six hours a day the woman spends on food,

which after piling up the indictment closes,

And the slow finger of heredity
Writes on the forehead of each living man,
Strive as he may,
"His mother was a cook!"

It would seem that when Giant Power really gets hold of the problem of making its contribution to human life, heredity might be found writing a good many other things on that forehead besides that. The configuration of the noble brows of the next generation—but two or three—might even manifest the fact that while "mother" was a superlative cook, she did cooking on the side, and that she transmitted to her offspring not only a good digestion, but an outlook on life born of her own wider participation in it.

It seems to me that this is what Giant Power is for,—what it can do for you and me and little Mary Jones,—if she will only wait till these things are established before she is born!

The Abolition of Household Slavery

By Mary Pattison
Formerly President, N. J. State Federation of Womens' Clubs

THE "Macedonian" cry of the home woman is at last reaching the ear of the engineer and inventor as well as the manufacturer and electrician and in fact is being picked up by the artist, the musician and the educator. Even the expert business man is listening to the call for better home conditions on his way to "larger" things—though in truth there is nothing larger nor more important in the nation's welfare than the twenty million homes — around which all other industries center. The National Better Homes Movement is a sign of the realization of this. Officered by the best that Washington can supply, and sponsored by the General Federation of Clubs, it bids fair to become a permanent feature of wide significance in home progress. But without the modern power that electricity does and can supply, a new order of betterment would be well nigh unthinkable. Already our first move in the morning may be at the call of an electrically regulated clock. Much of our toilet is performed to the tune of this power. We eat a breakfast entirely prepared by it. And whether we clean the house, wash the clothes, prepare the vegetables, nurse the sick, or cut the grass, electricity in its application is our constant companion through the day—yes, even on into the night, with lights and music and the dance. Its actual use is unquestioned—its future possibilities as yet undreamed.

Emancipation of the Housewife

Perhaps the one machine most widely welcomed and universally adopted is the vacuum cleaner. Woman has been a dirt eraser for so many ages with no relief in sight and no hope of anything better than beginning again at the moment of finishing, that one wonders whether the romance of dirt has not kept pace with the degredation of its daily influence and perhaps finally won out in the ultimation of the cleaner. For of all the modern electrical home machines in daily use this one pays a smaller interest on the money invested than do most of the others, yet it has a gigantic value in lifting the woman from her long and seemingly doomed relationship with dirt in the wrong place. Dust or dirt in the right place seems to be the medium of the creative process. All growth, beauty and civilization are dependent upon it—the world is unthinkable without it. But on the best chair or the living room floor we feel it has no part and should be carefully removed. The machine that removes it, sucks it right out of the house altogether, costs in the neighborhood of seventy-five dollars and is used in the average home about two hours a week. The old broom had at least a half day record. About the same intelligence is needed in the operation of each, although the cleaner requires far more thought and care to keep it in fitness and can be as successfully handled in a dinner or calling costume as with apron and cap.

Another great transformer of household drudgery is the electric washing machine. This is about as popular as the vacuum cleaner and really does a heavier and more irksome task in a

surprisingly acceptable fashion, requiring only about one-fifth of the time and no particular skill or strength. The average washer woman is now rated at between four and five dollars a day and is quite a scarce entity at that. So that this machine together with the ironer pays rather a high rate on the investment—in lieu of the uncertainty of the public laundry—even though the machine does service but for a few hours a week.

The biggest modern aid to the household as we find it is the electric cooker, notwithstanding the many curses heaped upon it. This it is that transforms the old order of "woman's work never being done" to the new and magical one of "touch the button and we'll do the rest." Better food, better cooking and better conditions generally result from the wise using of this device. With an automatic starter and cut-off the cost in current covers only just what is used with no waste and no wasteful attention. When we think of the old coal range and stove with the kitchen fire constantly on one's mind, it is wonderful that the woman of many cares ever did get beyond its black and heavy influence. The little electric cooker can be plugged into a lamp socket, filled to the brim and left to start and stop itself with right royal results; costing no more in current than the price of 2½ kilowatt hours[1] with nothing for attention and no dreaded pots and pans to wash after the best meal you ever ate is over.

[1] A "kilowatt hour" (one thousand watt hours) is the unit used in measuring and selling electricity as the bushel is used in measuring wheat or potatoes, the gallon for gasoline, the dozen for eggs or the pound for butter. A 25 watt incandescent bulb giving light equivalent to 20 or 25 candles uses 1/40 of a kilowatt hour if kept turned on one hour. A kilowatt hour of electrical energy will keep such a lamp going for forty hours.

Then to the dishwasher—a device that makes as nothing the most generally disliked task of all the household list! It is finally perfected to do the work as well or better than by hand—as well because it makes them over 95 per cent clean and better because it does it in three minutes instead of thirty, protecting the dishes from breakage or nicking and then polishing and sterilizing them on the way with no effects of greasy or dirty water to contend with.

In many cases the electric refrigerator is an investment worthy its price. In some cases not. That it is a huge convenience and comfort to have food kept at an even temperature goes without saying. No moisture and no waste, no iceman and no ice compartment to clean. At the same time no home-made ice cream with oodles of ice to waste. But one must needs sacrifice something in the gaining of something else. The refrigerator is here to stay and take its important part in the well-equipped home of the future thus doing away with the iceman and the iceman's tracks.

Speaking of tracks, the electric scrubbing machine is another modern power device of untold value. It cleans and polishes floors, scrubs the porches, as well as the kitchen, and washes and cleanses both rugs and carpets. Costing $150.00 and practically lasting a lifetime, it pays a high interest on the investment even though used but a small portion of the year. To keep floors in good condition is the economical way to have waxed floors. Frequent treatment with an abundance of heavy rubbing is all they require for years and nothing but a power polisher makes this practical in these days of high hand labor costs. Hence a machine that one might imagine only of occasional value becomes an invaluable possession where

floor space warrants any such service, if we rate it by the year and not by the infrequent usings.

Another little Giant Power possession of the greatest sort of value is the universal motor for all kitchen purposes, such as grinding meal and flour, making bread and cake, grating cheese or chocolate, milling coffee and spice, beating cream and eggs, polishing silver and brass, freezing ices or shelling peas, cutting beans or peeling potatoes—it does them all and more equally well. It is a veritable "motor of all work," taking the place of both man and maid and leaving rest, not fatigue, in its wake, and so constructed as to use any size and kind of vessel or pan that can be turned with a rod or a pin. The whole outfit costs less than a hundred dollars and can be made to return 300 per cent the first year, even in the average small family. Of course where conditions have brought the kitchen to the primal simplicity of a gas jet and a can opener with a delicatessen near by, it may not be the place for this sort of motor. But where health and care in food preparation is considered it is one of the best of big tools. It brings one nearer to nature and nature's best than the most fastidious shop and therefore to the way we should, but do not, eat.

These are but a few of the larger power household devices now in use in the one-family home. Many more there are and many more there will be as soon as the average woman can be made to think in terms of mechanics and not hand housework, in business methods not personal ones and in social and cultural motives and not self-sacrifice and self-degenerating tradition.

RISE OF A NEW ERA

Thought goes before action. One must think out one's salvation if one would be saved, yet most people want their thinking done for them—canned fashion. Giant business like Giant Power has marvelous advantages but it also has its paralyzing effect. It tells you what to have and how to have it and supplies what the thoughtless demand. If the good public could only put in its request for the well considered benefits it could and should have we might all be controlling the heating of our houses with a turn button instead of a coal shovel; living in an atmosphere of electrically driven engines, sootless and smokeless; enjoying heavenly music of a wireless order and going to college over the radio even though we are fifty or more years of age. Indeed, greater things than these shall be done when the dear women of the home awake from what *has* been, and when they demand an equality of purpose and not merely of position with the modern man of big affairs.

To curl and dry one's hair with electricity, to warm one's fingers and toes, to make some waffles for luncheon and percolate coffee at night is all very well, but it does not go far enough. There must be some big fundamental changes in this home of ours if it would be the social unit it gives promise of being. It might at least be brought up to the standard of the best factory and office system and of course go far ahead in its own individual charm.

These changes are first largely mechanical and electrical. They have to do with the management and methods of home making—not with the psychological or personal results, although they make clear the way for these while furnishing the leisure and inclination to develop and enjoy them. The cry of the home honored woman to be released from the dish pan, the tub and the kitchen range is answered. It is now a matter of how far she will go on the new road and what amount of culture she can and will take on in the performance

of the common task. From a musical standpoint she can move as far as time, tune and rhythm can be made to play upon her daily routine. Artistically we find every effort being brought to bear upon the home to give it the atmosphere it deserves. More and more beautiful things and effects are rapidly being incorporated. The artist is awake to this need and the woman is moving slowly in the wake of such suggestion.

The old idea of domestic service has gone. The new one of domestic independence is here. One of the chief differences is that while the dainty lady of the past had but to express her wish to have the work accomplished, she must needs now be the manager and accomplisher in one. A certain leisure was granted her by right in which to pursue the more cultural arts. The same leisure must now be earned by self-effort with the arts and culture as a part of the job. Ignorant help and mechanical progress are unthinkable in combination. Shall we then cling to the dish pan, the broom, and the washboard for our own isolated selfish end because we can perhaps still hold on to the servant that goes with these things? Or shall we move apace with our social and industrial lights and help to usher in a new order of service—trained, intelligent and scientific—by first working out the problem for ourselves? Giant Power is ours! We need but connect the wire of progress and touch the button of independence to prove to ourselves and each other that education and culture lie in mastering the technique of the *common* task. All the helps in the world are of no use to those who will not help themselves. The surprise of the feminine life will be when it is discovered collectively and personally that you can get out of housework all you have the brains to put into it.

Bituminous Coal—A Raw Fuel or a Chemical Resource

By Judson C. Dickerman

Assistant Director, Giant Power Survey, Commonwealth of Pennsylvania

LORD BACON, about the time of the early English settlements in America, realized that bituminous coal was capable of yielding "spirits" of remarkable characteristics. With improving means for controlling the evolution of distillates upon heating coal with exclusion of air, wise men experimented until, at the close of the 18th century, Murdock in London began to sell illuminating gas made from coal. Other wise men continued their study of coal as a chemical substance capable of meeting the world's needs for a variety of products, until today we have large amounts of bituminous coal being treated in by-product coke ovens, in by-product recovery gas producers, and in gas retorts of various patterns. Yet only about 100,000,000 tons of bituminous coal, out of about 1,100,000,000 tons of so-called soft coal annually mined in recent years, have been treated with by-product recovery, of which about one-half is so treated in the United States.

Today the demands for the comforts and conveniences of life are primarily based upon bituminous coal and its derivatives. Heat and power, fuel in the form of coke and gas for the reduction of metallic ores and the working of metals; illuminating and fuel gas for town homes and industries; ammonia for refrigeration, fertilizer explosives, and other chemical manufactures—notably carbonate of soda; benzol, tuluol, napthaline, creosote, and other hydrocarbons as the basic materials in the manufacture of dyes, disinfectants, explosives, essences and perfumes, medicinal compounds, photographic chemicals, solvents, wood preservatives; heavy tar and pitch for waterproofing, roofing and paving, paints, insulators, electrodes and briquetting material, all have their chief present and prospective sources of supply in the products of the carbonization or destructive distillation of bituminous coal. Some individual materials embraced in the above enumerated groups or products are obtainable from other sources; some dyes, such as indigo, cochineal, etc., are obtained from vegetable and animal sources; ammonia is now made by combining gaseous nitrogen with gaseous hydrogen under the influence of a catalyzer. But the source of nitrogen is the atmosphere from which it must be abstracted by the use of power, which must be considered as derived from coal. The hydrogen is obtainable either from coal gas by a pressure process, or by the electrolytic decomposition of water; either method goes back to coal as an indispensable agency.

In certain localities, petroleum, natural gas and water power furnish cheap and large amounts of heat and power. The available supplies of petroleum and natural gas, according to the estimates of qualified students of the subject, can meet the ever growing demands upon them for less than a generation. Even now with large production, petroleum and natural gas represent scarcely 15 per cent of the energy utilized in the United States. Water power supplies about 6 per cent. It has the great advantage of being practically renewed year by year. Therefore, while some individual operation may be carried out successfully and

profitably through the use of water power, in the large, any such operation must be considered as requiring its share of the fuel consumption of the world. Coal power may be taken as of the order of 75 per cent of the present supply of energy from all sources. Eliminating anthracite, leaves from 65 per cent to 70 per cent of the energy requirements of the country (other than animal and human) which must come from so-called soft coals.

POSSIBILITIES IN BY-PRODUCTS

To the ordinary man coal is still merely a fuel, to be burned raw. As all too commonly used, it is recognized as also more or less of a nuisance maker with its dust, smoke and odorous gases. To the scientist and the socially wise it is an indispensable but not inexhaustible source of much that civilization holds dear. Its combustion raw to such minds is a perversion of a gift of nature nearly on a par with burning corn or wheat merely for fuel. In the United States our great original forests are so far gone that another 30 or 40 years will see the end of our "virgin" timber. To make the most of what we have remaining and of what we shall get in the inferior second growths, we need large amounts of creosote oils as timber preservatives. We now import over 40,000,000 gallons of creosote oils, valued at about 10 cents a gallon, at the same time that we are burning raw hundreds of millions of tons of bituminous coal that would yield from 2 to 7 gallons per ton. Rapid increase in the use of creosote oils must take place. Dr. Henry A. Curtis, nitrogen expert for the United States Government, estimates the net annual loss in nitrogen content of the soils of the United States as 3,550,000 tons. Diminishing fertility of the soil follows the loss of nitrogen. By-producting all the bituminous coal mined in the United States by the present utilized processes would furnish just about one-third of this deficit. We are extracting petroleum from the ground and consuming it at a recent rate exceeding 500,000,000 barrels or 21 billion gallons. We obtain from petroleum 7½ billion gallons of gasoline, mostly used for automobile and small stationary engines. But the probable sources of supply of petroleum are being exhausted, so that in 10 to 20 years the shortage will become acute. Meantime our 500,000,000 tons of bituminous coal annually burnt raw could be so treated as to produce 2 billion gallons or more of light oils suitable for automobile use. Eight hundred billion cubic feet of natural gas are being annually distributed, but the end of the supply is in sight. Even now, billions of cubic feet of manufactured gas are being pumped into the natural gas mains to meet the demand for gas. Depending on the process used, coal gas equivalent in heating value to from 2000 to 6000 cubic feet of natural gas can be obtained from a ton of bituminous coal, or the possible gas made from over 500,000,000 tons would replace the natural gas with plenty to spare for increased consumption.

These figures are indicative of the "mining" of extremely important natural resources, in the shape of timber, soil fertilizer, natural gas and petroleum, at the same time that our method of use of bituminous coal is destroying completely its capacity to produce important additions or aids to the supply of these very necessary materials of civilization.

It is true that any process of treating coal to produce by-products involves the consumption or disappearance from usefulness of a portion of the coal substance and energy. This loss is of the order of 8 per cent to 15 per cent under good management, varying with the method and the coal used. These proc-

esses leave from 65 per cent to 75 per cent of the coal substance and a nearly similar proportion of the heat energy of the raw coal in the solid residue or coke, which on the average can be more economically used than the same amount of heat energy in the raw coal. The other 15 per cent or 20 per cent of the coal energy appears in the by-products whose efficiency in developing power and in applying heat is from two to five times that which can be obtained by the direct use of raw coal. Therefore, the loss of energy due to the treatment of the coal is more than made up in the final results of use; at the same time, the saving in labor and material when the products are properly used, represent net gains in values.

The effects of by-producting may be tabulated on the basis of our experience with the High Temperature process.

To carry out by-producting of bituminous coal there is involved a consumption or loss in energy of 10 per cent–15 per cent of the original coal and an expenditure of labor and use of capital equivalent to about $2.00 per ton of coal carbonized.

There results however:

Energy in solid residue, applicable generally with better efficiency than the raw coal, 65 per cent to 75 per cent of the original coal.

Energy in the gas evolved—utilizable with two to five times the efficiency of raw coal, 12 per cent to 13 per cent of the original coal.

Energy in form of tar and tar oils usable with a decided gain in efficiency as a fuel and containing material of marked value for chemical manufacture, 4 per cent to 6 per cent of the original coal.

Ammonia—energy very small, but increase in value very great proportionally.

Saving of energy lost in the form of smoke, soot, and unburned volatile compounds of the coal when fired in all places of use but the most complicated modern boiler plants, 5 per cent to 25 per cent.

Saving in the property losses due to smoke and soot.

Saving in labor in homes and industries through use of gas as fuel.

WASTE OR CONSERVATION?

The great social advantages, yes, the real necessity of immediately utilizing to the full the possibilities of our bituminous coal must be manifest from the above. Are we as a people going to wait until the supremely important materials in part noted above are practically exhausted and then frantically attempt to find impossible substitutes or to conserve the leavings, or shall we find means to be provident and reduce possible wastes and practice methods of production and utilization of coal which will aid materially in conserving these other important materials? Are we going to be a little worse than and duplicate the history of the Chinese with their hills barren of forests, their soil washed away, their civilization at a standstill because the means of providing ample foodstuffs—at the same time leaving abundant labor free to work with the other natural resources—was ruined by the destruction of their forest and land fertility, and their ignorance of the usefulness of their coal deposits to retard or even prevent such disaster. We are not ignorant of the means and advantages of utilization of coal and other mineral resources to conserve the fundamental requirements of a wholesome, long-lived civilization.

The whole fuel situation should not be viewed as a field of unhampered individual exploitation of a single feature of its use. Mining, power production, by-producting and at least starting distribution to the manufacturer or ultimate consumer, of the

several products, obtained thus most economically because of co-ordinate group handling, should be embraced under the same management. To ensure the greatest economy and the greatest conservation, the operations under any one management must be large, handling something like 25,000 tons of coal a day. Such a condition may involve some form of active public interest or regulation.

A "vertical" operation of this kind would be usually located in the mining fields. It would raise to the surface and utilize 10 per cent to 20 per cent more of the coal in the ground than is now raised; it would sort its coal and treat it in several processes to fit the demands of the market; inferior or non-saleable combustibles would be used to produce electric power; selected coke, briquetted smokeless fuel and gas could be sold, by-products could be worked up to a sufficient extent to find a market independent of the present limited market, due to there being virtually but one buyer of crude recovered tars and oils.

The processes available may be divided into:

(a) High temperature (1600°–1800°Fah.) by-product coke ovens, such as are commonly operated in connection with large steel producing plants, producing hard metallurgical coke, tars, ammonia and gas.

(b) High temperature gas producing ovens or retorts, recovering by-products of ammonia, tar and coke of somewhat different characteristics than that produced in metallurgical coke ovens.

(c) Low temperature (1000° to 1300° Fah.) carbonization plants, producing rich gas, high grade oil and tar acids, and a smokeless coke still containing 8 per cent to 12 per cent volatile matter, making it easy to kindle.

(d) Complete or partial gasification plants, operating on the producer or partial combustion principle, recovering by-products, which by-products are evolved in part at low temperature, in part at high temperature with or without production of coke. The gas produced will be large in volume and carry 40 per cent to 60 per cent of nitrogen and low in heating value, but particularly useful in most industrial furnaces requiring gaseous fuel.

The high temperature coke and gas oven processes will continue to grow with the growth of the steel industry and the demand for large volumes of medium heating value (500 to 600 B. t. u. per cu. ft.) town gas. It will supply some smokeless fuel as coke, in place of high-priced anthracite or lumpy soft coal. By careful preparation of the coke and proper educational campaigns considerable coke can be sold for domestic use. Dropping the idea that it should be sold at a price to compete with anthracite and endeavoring to produce coke at a price that represents only a moderate increase in price over its equivalent in raw soft coal, should result in a far wider market. This process should be encouraged as widely as possible since it is a fairly good producer of ammonia, tuluol and benzol. The present important coal tar dye industry is based on the tar products of this process.

The low temperature carbonization plants should be particularly applicable to pretreatment of fuel designed for large power and heating plant use. The by-products are particularly desirable because of the large yields of petroleum like oils and of creosote oils. The solid residue if obtained as, or made into, suitable sized, coherent lumps, will be especially useful as fuel for domestic and heating plant use, where the large volume and seasonal intermittency of use makes gas too expensive. The most promising development

of low temperature processes appears to be especially suited for operation in connection with large power plants.

There is a definite need for large amounts of gas fuels in certain industries like glass and steel manufacture, which can efficiently use low heating value gas. For such cases, the by-product gas producer has a sure and important field. Engineers are today advocating and applying such producers for use in connection with large power plants, the gas generated being burned efficiently under steam boilers. These producers can be so operated as to produce three to four times as much ammonia per ton of coal as can the high temperature ovens.

A NEW ERA

It would appear that we are on the verge of beginning a new era in handling our bituminous coal resources.

Mr. Henry Ford, in his power plants at Detroit and Walkerville, Canada, is constructing low temperature carbonization plants, as a preliminary to power production, and as an adjunct to existing high temperature coke ovens.

We learn that several power plants in Scotland, England and Germany are installing such by-product recovery plants. The public is increasingly utilizing efficient and clean fuel gas. The discovery that by-product benzol or light oil is an anti-knock fuel of greater efficiency in auto engines than ordinary gasoline, increases the demand for that by-product. Perhaps all that is needed is a strong public demand that the nuisance of soft coal smoke shall be eliminated, which will cause the necessary production of smokeless fuels which mean, in turn, recovery of the higher values in bituminous coals.

The Changed Significance of Load Factor[1]

By Otto M. Rau
Consulting Engineer

THE success of the electric power industry can be attributed largely to the importance it has given to load factor. The profitable development of the industry can be traced to its acceptance of a rate structure based on the customer's maximum demand for service rather than on the total quantity of power used by the customer.

In this the industry has differed from most other commercial enterprises. The early development of the business, during the electric light company period, was guided in some measure by the principles which had been developed by the gas companies. Unlike the gas business, however, the electrical industry could not, during favorable or economic periods, manufacture and then store the product, delivering it as the customers required the service. The business had to be regulated so as to supply electric current at a moment's notice and in any quantity that the consumer should demand. This required the continuous operation of the plant with sufficient equipment available for any call the consumers might make. Whether power was being drawn or not, the equipment to carry the greatest expected load had to be in measured operation at all times. Consequently efficient production was impossible. Of course boilers and engines were automatically checked and otherwise regulated to meet probable demands.

These early plants had load curves which showed that the entire capacity of the plant was used for very short periods, often of less than thirty minutes per day. This usually occurred during the heaviest lighting period, and created the peak load or critical period of the daily operation of the plant.

Some relief was looked for through the possibilities of storage batteries, which, it was anticipated, would function in the electric lighting industry somewhat as does the gas holder in the gas business. Low efficiency and heavy maintenance costs, however, in addition to the expense of installation of such equipment, made this impracticable.

The Load Factor and Ensuing Changes

It soon became apparent that gas practice in marketing electricity could not be followed, and that in some way the costs of operating during the non-productive periods must be absorbed. Thus the load factor—the percentage of time over which the maximum demand for service was extended—became the basis on which electric service was sold. This method of arriving at the charges to be made, produced two important changes in the industry. First, it resulted in a more careful use of the service, by restricting the demand and creating a diversity in its use by each consumer, in that no more lights than absolutely necessary were used at one time. This in turn re-

[1] This is a suggestive discussion of a vitally important factor in electrical development. Electrical load factor must attain an increasing importance in our social economy due to the wider application of electricity. But revolutionary changes in production and transmission methods may suggest new ways of affecting and utilizing the load factor for the public benefit. That we must shift present moorings seems fairly evident. —The Editor.

sulted in a relative lowering of the peak load or demand. Second, it caused a longer or more extended use of this maximum demand, as the quantity of energy used by the customer but slightly increased the cost so long as the maximum number of lights necessary at one time was not exceeded. This had the effect of broadening and flattening the peak load until today the peak has practically disappeared or rather it has become a plateau.

The importance of this principle in the development of a prosperous industry was self-evident during the electric lighting period of the electric power companies. With the advent of the electric power business—as contrasted with the electric light business—and its application as industrial power, the use of the service was extended quite generally over the usual working hours each day. The power plant equipment was called on to deliver energy, much as any manufacturing plant operates its equipment to manufacture its particular product. In place of a thirty minute or shorter production period it became a plant operating at capacity for eight or ten hours. But unlike the average manufacturing plant the electric plant could not shut down until morning for another day's production, but had to operate and be prepared to serve any demand during the entire twenty-four hours each day.

The situation, however, of the average manufacturing plant is in some respects more favorable than that of the electric power industry. The fixed charges for plant investment are similar as to their apportionment over the period of production, but total operating expenses are increased, due to the necessity for having the production facilities available during the entire twenty-four hours instead of closing down when production ceases.

The minimum necessary operating capacity of a plant is that required to produce the maximum output, or peak load, for any one moment, and the length of time this output is maintained is the duration of the peak load. The ratio of the average load to the maximum load is the load factor. It is therefore apparent that, if the peak load should continue for twenty-four hours, the load factor for that day would be 100 per cent.

The average electric power company operating in a diversified industrial district usually obtains a load factor in excess of 40 per cent, not through any particular efforts of its own, but due to the nature of the industries and communities it serves. In less diversified districts the load factor varies from 10 per cent for a small plant supplying chiefly electric lighting, to 60 per cent or more, for a large plant operating in industrial districts having long periods of continuous operation, such as in the steel industry.

In the state of Pennsylvania the average load factor for all electric power utilities is approximately 40 per cent. By effective interconnection and by taking advantage of the diversity of the demand on each plant, the average load factor will be materially increased, and from a study made of the operating statistics of the companies, may presently reach 50 per cent.

In applying the load factor principle in developing the industry, a successful method for producing a profitable business was established. During the period when the natural demand for service was low, the basis for a rate, which recognized long-hour use, gave an incentive to the consumer for developing such a use for the service. However, this period of development has passed—the normal use of the service averaging above 30 per cent—and, as a result, the load factor has lost its former significance. It has become

impossible to assume that any part of a plant is held in reserve for a particular consumer—certainly for a longer period than that during which service is actually called for. Therefore the principle upon which the charge is based—that the individual demand for service requires a certain station capacity to be held in readiness for twenty-four hours—does not apply as strongly with a present load factor of more than 30 per cent, as it did when the load factor was less than 5 per cent.

With the extensive uses of electric service as developed today, the load factor has reached a point where it compares with that of ordinary industrial activities. In the main, maximum demand is maintained during the so-called working day. The same theories which developed an industry having a production period of less than a half hour into one having a production period equal to that of the average factory, by providing the necessary incentives, can extend the use of the equipment which must be held ready to serve twenty-four hours each day.

The use of electric service throughout the working hours of a day is about constant with the exception of a few months in the year, when the demand for office building and display lighting overlaps the power load. During the balance of the year this lighting load tends to improve the load factor as it extends the use of service beyond the working hours of the day. Domestic service through the use of electric household appliances has created a diversified consumer. A modern electric house may readily have a peak load before noon.

The station capacity required to assure continuous service for the peak demand required, of course, equipment in excess of that used to supply the peak load. Accepted practice requires that sufficient spare apparatus be available so that in case of trouble the service can be maintained without interruption. With a flat peak the spare apparatus held for emergencies becomes available during the short periods of excess demand, when as for instance the lighting load overlaps the power load. This causes no impairment of the continuity of service.

This development in the use of electric service suggests the relatively small weight which the load factor now exerts in increasing a use for service during the present non-productive period of the plant. Why should load factor be assumed to be the cause producing a load which already exists? The average demand for service has a load factor approximating 40 per cent. Therefore, the cost of service should be based on the cost of producing power at the average load factor, and applying an incentive to use service above this average. This will have the same effect on prolonging the present eight hour peak that the early efforts had on prolonging the few minutes peak to its present duration.

The task of increasing the use of power plant equipment beyond the normal period established by present industrial practice will no doubt be more difficult than that required to bring the load factor to this average. By basing usual service on average costs and applying a bonus for service above the average, the same incentive will be given for developing the present idle period of the generating facilities that the load factor principle gave in its early application.

The necessity for a high load factor in the production of low cost power from Giant Power plants is of first importance. The construction of these plants with the necessary transmission lines requires large capital investment. The fixed charges are constant, irrespective of the operation of the

plant and may readily exceed the total operating expenses in manufacturing the power.

Restricted to a 30 per cent load factor, the fixed charges for generating current in any efficient station will approximate 6 mills per kw.h. which is in excess of the operating expenses to generate the power. By increasing the output so as to obtain a 60 per cent load factor, the fixed charges will be 3 mills or 50 per cent less than the operating expenses.

To increase the use of service above the prevalent demand a low rate must be established. This will encourage industry to adjust operations so as to take advantage of this low cost power, and will develop uses for electric power which the present system of basing the charge on load factor prohibits.

Arriving at the cost of service from the average load factor of the plant may slightly increase the cost of service to the largest users, but will materially decrease the cost to the small consumers, making possible a very low rate for power used over and above the established average load factor. As all the fixed charges are absorbed by the consumers during the period of normal use, only operating expenses are left as the basis of charge for power used over and above the average load factor of the system.

The electric power utility, being a regulated industry, cannot earn a profit beyond that prescribed by law. A reduction in rates is frequently required to adjust the net income so as to remain within the prescribed limits.

With the creation of Giant Power sources, prime power will be available at a cost dependent not only on the average load factor of a local district, but on the diversified activities of great areas which may extend beyond the state lines. This will assure a power cost based on average use, and by adjusting rate schedules to average use, changes in rates will be adjusted automatically, depending on the use of the service by the consumers.

Invention and the Power Future

By Arthur A. Hamerschlag

Formerly President, Carnegie Institute of Technology; President, Research Corporation, New York.

THE outstanding topic of the day is power and more power.

At first glance the figures compiled by the Superpower Survey of the Federal Government appear incredible. But even more startling is the knowledge that our great power plants, even when operated to capacity, are far too small in number and size for the requirements of the territory they serve.

Let us pause here to note also that these requirements are growing at a faster rate than any development program thus far announced in public.

In recent years the development of hydro-electric plants has been very rapid. Their size has only been limited by a volume of water which they are to use. Individual units, forming part of the plant, have increased in capacity fourfold and it is questionable whether they have not reached the limit of economic proportions.

The Existing Situation

The demand for hydro-electric locations has been so great that nearly every stream, in which there is sufficient head and flow, has been preempted and will utimately be used. Even rivers in which the flow is very irregular and seasonal, such as in the southeastern part of the country, have hydro-electric plants which must be supplemented by steam-coal operated plants with which to meet the insistent and increasing demands for power.

This combination, while helping to solve the problem, has added a heavy toll to the cost of producing electrical current which mounts higher and higher per kilowatt or horsepower of installation. These costs are higher than in the old days. The capital investment must now include extensive dam construction, provision for the impounding of water great distances back from the dam site, and the capital cost of the auxiliary steam power plant, that may be idle during many months but gives a continuing expense, which must be absorbed before the current is sent into the line to be sold to customers.

These hydro-electric installations with their auxiliary power plants, no matter how efficiently they are operated, produce current at only a very small fraction less than the best equipped and most modern power plant using coal as fuel.[1]

Power stations, wholly dependent upon coal, have attained a size which staggers the imagination. Already we have in operation the 300,000 kw. unit.[2] The 500,000 kw. plant is under construction, and others, concentrating even more power at one station, are under contemplation awaiting bids from contractors.

But it is sufficient for this article to mention that transmission difficulties—that is the line losses over distances of ground—seem to be more than offset by labor-saving devices,

[1] In some instances—perhaps in an increasing number of instances—power derived from falling waters cost more per kilowatt hour than the same current can be maufactured for the steam station.—The Editor.

[2] Stations of this size have undoubtedly been planned. But the largest coal-burning station in actual operation is the Genne Villiers Plant, near Paris, with a rated installed capacity of 240,000 kw. We have two or three stations in the United States almost as large.

which can be placed within the plant itself, and which, therefore, make the question of distance transmission less important than in the old days.

The American practice in power plants seems to follow quite definitely two generic lines of development, hydro-electric and steam power, both of which are dependent upon an abundant supply of water. The hydro-electric cannot operate unless it has sufficient volume and head to produce enormous power for a large portion of the year. Steam plants require abundant water both for use in the boilers, and for larger quantities for the cooling of the exhaust steam. The amount of water necessary for this purpose can be partially visualized if one remembers that the temperature of the East River at New York has been raised ten degrees by the users of condensing water, and an even more startling figure is that of the Allegheny River at Pittsburgh, where the temperature has been raised twenty degrees.[3]

No feasible plan to operate power stations has thus far appeared which can dispense with enormous quantities of water being available.[4] Therefore, any attempt to consider the location of power plants near the mines is entirely dependent upon some satisfactory method by which the water requirements could be brought to the mouth of the mine; almost as difficult a task as it would be to transport coal in the other direction.

INVOKING THE INVENTOR'S AID

This brief summary of the existing situation is necessary as a preamble in discussing the place invention is to have in the power future. There have been a number of main objectives. They can be summarized as follows: the improvement of the transmission efficiencies over long distances; the reduction in the operating labor charges by the enlargement of the units of production; the reduction in labor charges by the utilization of labor-saving devices both in the plant and in the field for handling fuel and other materials; the satisfactory solution of insulation enabling high tension voltages to be in excess of 200,000 volts, as contrasted with the old 20,000.

But in spite of all of these very useful economies, very little has been done compared to what must be done if we are to satisfactorily meet the power requirements of our growing industrial life.

Standard practice definitely attacked first, the perfecting of the prime movers, such as the steam engine and water wheel, which have been replaced by the turbines; the gradual improvement in boiler construction permitting higher pressures and superheated steam to take the place of former practice; and lastly, and perhaps more important than the others, the more perfect combustion of the coal. Hand firing was succeeded by mechanical stokering and this, in turn, is being displaced by the use of powdered fuel, in which the combustion is so complete that the heat efficiencies are infinitely better than they were a decade ago.

Our deductions from these statements or premises lead us to look for greater efficiencies. But if we would observe the cycle of improvements briefly outlined above, we will note that we have been attacking difficulties that are close at hand and easily mastered, such as the elimination of the reciprocating engine by the concentrated work possible to be done by high speed turbines. The fact that research groups

[3] The suggestion has been made that it will probably become necessary to legislate against overheating of our streams. It is simply a new form of stream pollution.—THE EDITOR.

[4] This point is discussed in another paper in this volume.—THE EDITOR.

and inventors have made more progress is evident in the prime mover efficiencies, boiler efficiencies and fuel efficiencies within the power plant. There remains, nevertheless, the largest single item of expense, that is the cost of the fuel delivered at the power plant.

With coal at anywhere between $3 and $5 delivered at the plant, its importance must be evident and the items which enter into this cost are first, freight; second, labor of the miners; and third, handling. Therefore the project which is nearest the horizon of attack is that of reducing the cost of carrying the coal from the mine to the power plant. In certain stations this has been solved by the fortuitous combination of having an abundant supply of water adjacent to the coal fields, as in the Pittsburgh District, but in the rest of the country the solution is not to be found by any such happy condition.

Inventors have given some thought to this problem and have suggested the elimination of the freight railroad haul by pumping the coal from the mine to the station, even though the distances may be hundreds of miles.

There is nothing intrinsically wrong with the suggestion. It needs practical development to determine possible deficiencies and handicaps which may develop, but since we have been successful in pumping oil, gravel, sand and stone, there seems to be no reason why we cannot ultimately overcome any mechanical difficulties which may arise in pumping coal.

Another suggestion which is also frequently mentioned is the conversion of the coal, at the mine, into gas. If the gas is to be used under boilers, the high cost of the installation of equipment, in addition to carrying the burden of tremendously expensive storage facilities, mounts almost forbidingly.

If the gas is to be used direct, as has so frequently been suggested, in gas engines, gas engine development would necessarily have to undergo a great change. No reciprocating type of gas engine can ever hope to overcome its handicap of initial cost by any efficiencies of power production. The practice of the future must devise an efficient type of gas turbine even more efficient than the very best multiple stage steam turbine.

Emphasis is placed upon this statement because it must be evident to the technical world that the use of high pressure superheated steams, that is 500 pounds steam pressure with 800 degrees superheat, gives us something which competes with the best quality of gas and, therefore, any gas turbine would have to be much more efficient than a steam turbine with the same output, in order to have it become a factor in this program.

FUTURE EVOLUTION

With these considerations in mind the power future, in so far as it affects our industrial life, will witness a constant repetition of existing installations with minor changes of construction, the result of progressive evolution in size, capacity and the elimination of losses; and the evolution of newer apparatus, but like every other field of human endeavor, the horizon will always be beyond the head of the existing practice. We are witnessing today a constant repetition of units of power production based upon proved practice. They are, to a very great extent, imitative, and the experimental future development cannot be forecast nor predicted.

The experiment, which the General Electric Company made in the utilization of mercury vapor in its power plant in Connecticut, illustrates the determined effort and the research which sound a warning note that per-

haps we have attained the ultimate in hydro-electric and steam power plant efficiencies.

It is with some trepidation that I venture the suggestion that perhaps the evolutionary trend will take us into the field of low temperature distillation of coal; into the liquefaction of fuels, such as coal; or perhaps into that much more radical development when we are to produce sufficiently pure oxygen and utilize it, when enriched with hydro-carbons, as a source of sufficient heat to replace existing appliances and methods.

The power future of the United States is, therefore, today on the threshold of new departures in which the inventor holds the key which is to open new sources of energy.

The Influence of Water on the Location of Giant Power Plants

By August Ulmann, Jr.
Department of Mechanical Engineering, University of Pennsylvania

PRESENT day conditions of life are rapidly changing our economic status. As our demand for more and more comfort and speed increases, we are brought face to face with problems that crop up with very little warning. The warning perhaps is not so short as our willingness is lacking to heed the signs that point out new problems until the writing appears on the wall and we are forced into hasty solutions.

One of the present day problems that we are facing is the meeting adequately at a reasonable cost to the public the tremendous and ever-increasing demands for electrical power which we may almost say is so important as to be the life blood of our modern civilization. At least it vies with in importance, and affects the conservation of our natural resources of fuel, mineral and other sources of wealth.

The government of the state of Pennsylvania has shown wisdom in heeding the signs of the times in instituting the Giant Power Survey so that when the power situation requires it, a solution, in no sense hasty or partial, will be at hand.

Problem of Water Supply

One of the great objections that has been raised in the consideration of Giant Power plants located at or near the mine mouth is that very few mines are located near rivers large enough to furnish the water required. In the most approved modern power plant practice, water is almost as important an element as the fuel because the high efficiency now obtained in the changing of heat energy into electrical energy is entirely dependent upon large and adequate supplies of cool water. In the case of the power plants of ocean liners, which were the giants of previous days, the space occupied by the coal is so valuable, and the cost of the coal itself so high, that the utmost economy in the use of coal has been a well developed art for a good many years. But, as the whole ocean is available as a water supply, the question of the cost of the water does not enter into the problem.

In the early years of the art of power generation on land coal was not costly, and the question of fuel economy was not so urgent. The cost of the fuel was a relatively small proportion of the total cost of operation and it was well known that maximum thermal efficiency did not always produce the lowest cost of power. A great deal of labor had to be employed in the older type plants and labor saving was then the most telling economy.

Great strides were made in the saving of labor in power plants by the invention of the automatic stoker and the development of coal handling devices, motor operated valves and many other important and ingenious improvements both mechanical and electrical. The cost of fuel thus came to take precedence and economy in its use became the paramount problem. In addition, the rapid rise in the cost of fuel accentuated the importance of its economical use.

STEAM EXPANSION AND IMPROVEMENTS

Thus attention was directed to an effort to increase the thermal efficiency of all the elements of the power plant. Boilers were improved, steam pressures raised, superheaters and economizers were added and the science of combustion was studied minutely and to great advantage. The greatest development of all was the advent of the steam turbine and its rapid strides toward perfection. It reduced the cost of buildings on account of the small space it occupied, was found to be reliable and rugged and on account of the fortunate features of its design it was possible to make use of that great range of the expansion of steam that takes place in the pressures below that of the atmosphere. This gave rise to the rapid development of the condenser by means of which this great source of additional thermal efficiency is made available. The condenser is one of the oldest parts of the power plant. But due to the constructional difficulties encountered in the older type of engine equipment, which made very expensive the utilization of the whole of the possible expansion of steam in the pressures below atmosphere, its ultimate development was postponed until the advent of the turbine and the high cost of fuel.

It is the operation of the condensing equipment that requires the large quantities of cool water that are essential to a modern power plant. In order to produce the lowest terminal pressure of steam expansion possible all the time, about 90 pounds of water must be pumped to condense each pound of steam. This is common practice today and is the factor that necessitates locating a large power plant near an adequate body of water. In the older practice, before the advent of the turbine when it was considered ample to expand steam to one pound per square inch absolute pressure, 20 to 65 pounds of water were required to condense one pound of steam and the average for a year's operation was only about 35 pounds of water per pound of steam, about 39 per cent of present requirements.

Present practice, due to the high cost of coal, high fixed charges due to expensive equipment, and comparatively low labor and maintenance costs, finds that the lowest cost of power coincides with maximum thermal efficiency.

GIANT POWER PLANTS

Now comes the further development of the Giant Power chain of plants. High transportation cost of coal is forcing the plants away from the large bodies of water into the interior right to the mouth of the mine. The cost of fuel will go down. It will at least be cut in two and may perhaps be cheaper. The influence of the cost of fuel on the cost of power will be reduced and we shall return to old practice in that the lowest cost of power may not coincide with maximum thermal efficiency. Also the water requirements of the well-designed Giant Power plant will probably be much less than present day practice demands.

This has been recognized by a good many engineers and one man of broad vision has even suggested the other extreme and proposed doing away with the condensing requirement and designing the Giant Power plants to operate non-condensing.

In order to fully visualize all the elements of the problem, a calculation was made to predict as nearly as possible on the basis of plants recently constructed, the costs of operation of various plants designed to operate at

various pressures below atmospheric and with various costs of coal. This was done in order to predict approximately just what degree of thermal efficiency may coincide with the lowest cost of power for any cost of coal. Some of the elements of this calculation and its final results are shown in order to substantiate the statements previously made.

It must be borne in mind, however, that the cost of construction of the Giant Power plants will probably be materially lower than those used in this calculation for the following reasons: Existing plants are nearly all built in or near large cities where real estate values are high and buildings are expensive due to labor and material costs and the emphasis at present placed on architectural features.

Figure I is a graph which shows the increase of steam consumption of the steam turbine as the terminal or back pressure increases. The lowest possible terminal pressure known to present practice is about one-fourth of a pound per square inch absolute and can be obtained during the winter months only when the temperature of river waters is 37° or lower. As the terminal pressures increase the steam consumption per kilowatt hour increases rapidly until at atmospheric pressure the steam consumption is 74.5 per cent greater than 9.4 pounds of steam per kilowatt hour, corresponding to the lowest terminal pressure.

If the condensing equipment is omitted entirely so that the terminal pressure becomes atmospheric, 74.5 per cent more boiler and coal equipment must be provided at enormous expense and an equal percentage of additional coal must be burned. However, if the condensing equipment be modified slightly to maintain say a terminal pressure of one pound per square inch absolute, the steam con-

FIGURE I—TURBO GENERATOR STEAM CONSUMPTION

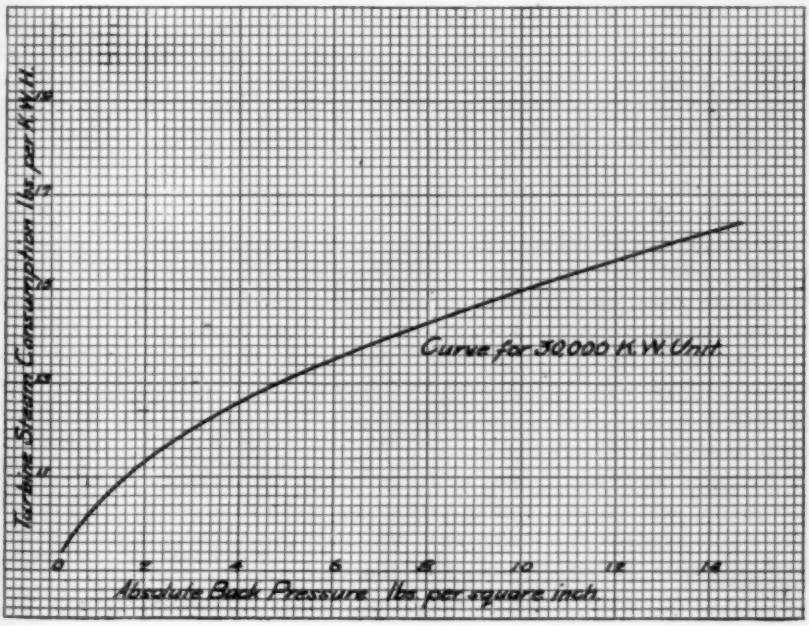
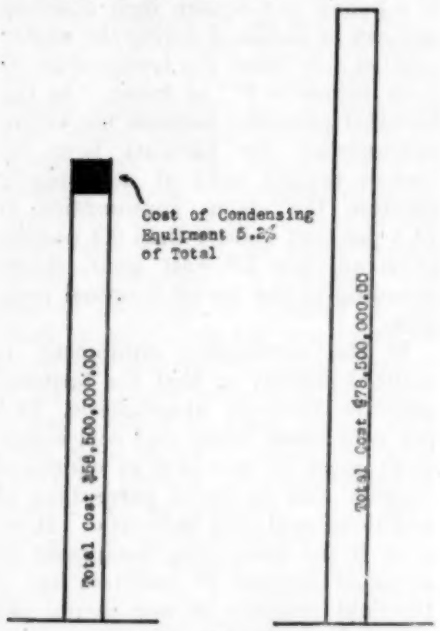


FIGURE II—COMPARISON OF COSTS OF CONDENSING AND NON-CONDENSING PLANTS OF 500,000 K.W. CAPACITY



By the expenditure of $3,000,000.00 in Condensing Equipment $20,000,000.00 are saved in the Cost of the Plant.

sumption increases only about 10 per cent and the cost of the plant is not materially affected, as the slight additional cost for slightly larger boilers is offset by the reduced cost of the condensing equipment.

In Table I is shown the different predicted costs of Giant Power plants designed for various terminal pressures. In speaking of the per cent increase of cost, the figures do not convey much meaning, but when actual total figures are considered the differences become staggering.

The comparison shown in Figure II conveys to the mind very vividly just how important a part the condenser takes in the make-up of the modern power plant. It cannot be safely thrown aside for three reasons:

(1) Capital expenditure must be conserved;
(2) Coal reserves must be conserved;
(3) Costs of power must be kept at the absolute minimum.

The condenser is the safeguard against the violation of these three principles.

Turning again to Table I, it is noted that the least expensive plant is that which corresponds to operation at one pound per square inch absolute back pressure, which indicates the possibility that with this plant may be obtained the lowest cost of power.

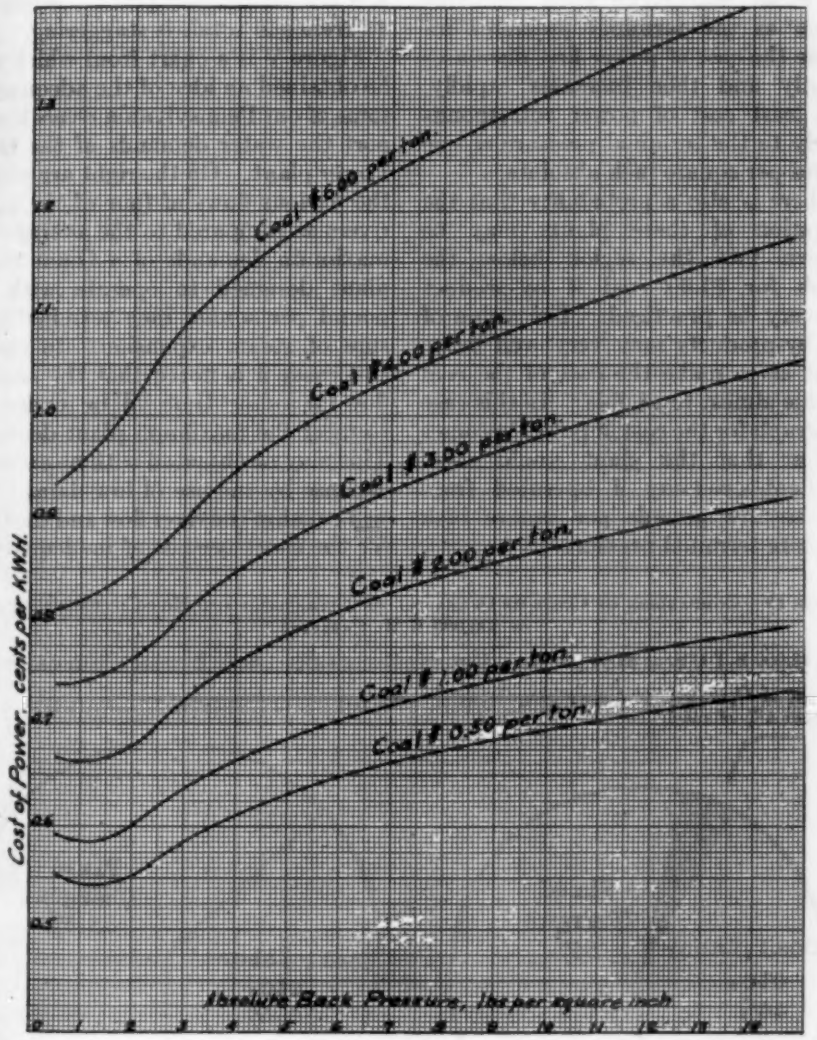
In Figure III is shown a family of graphs which are the result of a careful

TABLE I

(Costs of building the 500,000 kw. Giant Power plant designed for various absolute terminal pressures of steam expansion. Unit costs have been taken from plants actually constructed.)

Absolute Terminal Pressure Lbs. per Sq. In.	Cost per Kw. of Installed Capacity	Net Output in Kw.H. per Year	Total Cost of Plant
Least possible	$117.00	1,650,500,000	$58,500,000.00
1	115.80	1,681,050,000	57,900,000.00
2	116.10	1,685,465,000	58,050,000.00
4	128.50	1,686,878,000	64,225,000.00
7	143.50	1,687,523,000	71,750,000.00
10	147.00	1,687,773,000	73,500,000.00
14.7 (Atmosphere)	157.00	1,691,000,000	78,500,000.00

FIGURE III—COSTS OF POWER UNDER VARYING CONDITIONS OF COAL PRICE AND TERMINAL STEAM PRESSURE


Coal $6.00 per ton
Coal $4.00 per ton
Coal $3.00 per ton
Coal $2.00 per ton
Coal $1.00 per ton
Coal $0.50 per ton
Cost of Power, cents per K.W.H.
Absolute Back Pressure, lbs per square inch

analysis of the costs of operation in the seven hypothetical plants indicated in Table I. Horizontally are plotted terminal or back pressures and vertically the resulting costs of power in cents per kilowatt hour. Each graph corresponds as indicated to a different cost of coal. These graphs bear out the statement previously made that the lowest cost of power may or may not coincide with maximum thermal efficiency. The graph for $6.00 coal is representative of present day practice and it confirms accepted designs of today in that the lowest terminal pressures are sought after because the least terminal pressure shows the lowest power cost.

The Giant Power plants will operate in the region lying between the graphs for $1.00 and $3.00 coal. In this region as the terminal pressures increase the cost of power first decreases slightly and then increases rapidly. The least cost of power corresponds nearly to the terminal pressure of one pound per square inch absolute.

There is also a probability that the operation of these plants may be thrown into the region below the graph for $1.00 coal if by-product recovery be practiced. The value of the by-products may very well be so great as to make the cost of the coal residue almost negligible. In this case the graph for the cost of power becomes so flat that the plant would show excellent economy if operated from two to five pounds per square inch absolute terminal pressure.

Figure IV shows a comparison of the costs of operation for the condensing and non-condensing plant. Again the difference in totals is staggering.

Figure V is a chart from which may be obtained an idea of the adequacy of some of our Pennsylvania rivers to support the water demands of the Giant Power plant. On the right are plotted the various flows of four of the larger rivers as compared to the average and maximum demands of a Giant Power plant designed to operate with one pound per square inch terminal pressure of steam expansion. In one or two cases it is noted that the summer flow for a short time will be inadequate to meet the maximum plant demands. This may be obviated with no excessive expense by the use of low dams which will equalize the river flow and thus care for the short periods of inadequacy.

FIGURE IV—COMPARISON OF COSTS OF OPERATION OF CONDENSING AND NON-CONDENSING PLANTS OF 500,000 K.W. CAPACITY

Coal 13,000 B.T.U'S. at $2.00 per ton. Capacity Factor 40%. Back Pressure 1 lb. per sq. in. abs.

Cost of Operation of Condensing Equipment 4% of total.
Fixed Charges 56%
Coal, Labor etc. 44%
Fixed Charges 63.5%
Coal, Labor etc. 36.5%

CONDENSING PLANT

Cost of Operation per year = $11,134,000.00.
Net Kw.H. Output = 1,681,050,000.
Cost of Power = 0.663¢ per Kw.H.

NON-CONDENSING PLANT

Cost of Operation per year = $15,562,000.00.
Net Kw.H. Output = 1,691,000,000.
Cost of Power = 0.92¢ per Kw.H.

By the use of condensing equipment $4,428,000.00 is saved each year in the operation of the plant.

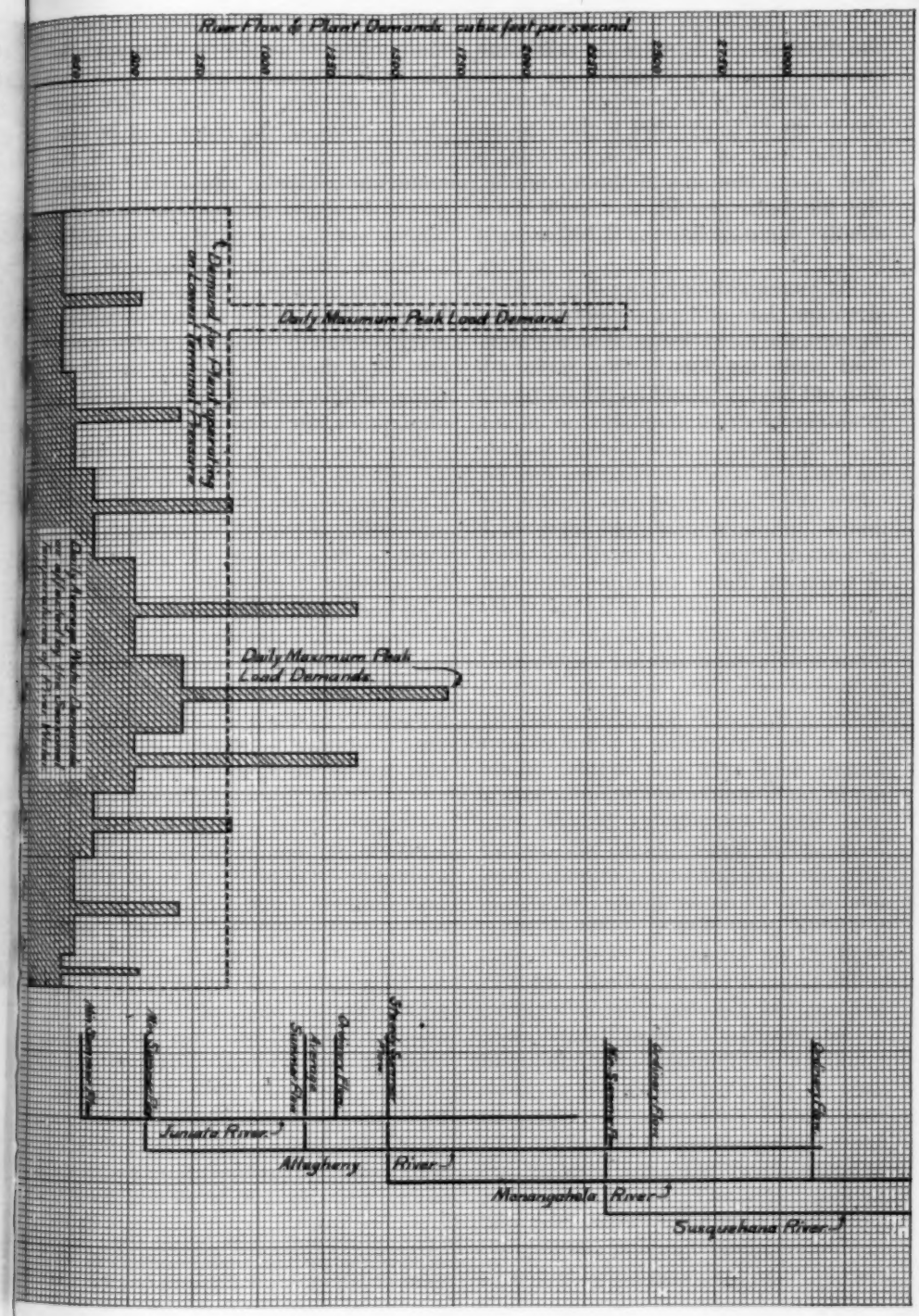

River Flow & Plant Demands, cubic feet per second.
Daily Maximum Peak Load Demand
Daily Maximum Peak Load Demands
Juniata River
Allegheny River
Monongahela River
Susquehana River

FIGURE V

Flood regulation works applied to the rivers would increase the minimum summer river flow so materially as to do away with this shortage and make the rivers fit to support a giant plant. In the case of the Monongahela, a river about the size of the Allegheny, this has been proved, as it now has a steady summer flow of 1,500 second feet.

If this regulation be applied to these streams, they will prove adequate to support the plant designed on the modified basis suggested. No great additional burden would be added to the probable low cost of power, as only a part of the cost of the development of these streams would be chargeable to the Giant Power plant.

Streams of much smaller flow than those shown on the chart may be used effectively if artificial cooling of the condenser water be employed. Recent power developments both in the United States and abroad have employed this principle in large installations with great success. Such great strides have been made in the construction and operation of cooling towers, spray ponds, etc., that there need be no fear of the costs of this cooling process being so excessive as to be prohibitive.

Consolidation in the Electric Utility Industry[1]

By JOHN L. STEWART
Member Public Service Commission, Commonwealth of Pennsylvania

IT is generally recognized today that the fundamental and underlying principle of public utility operation is the exercising of monopoly power under adequate and effective government regulation. It is evident that any benefits which might result from unrestrained competition, involving duplication of facilities used in rendering a public service, would be wholly destroyed by the economic waste which such duplication involves. This concept is not the product of abstract theorizing but of years of national and state experience with railroad and public utility enterprises. The form of monopoly which is objectionable is that which results from a uniting of organizations for the purpose of restricting output, increasing prices and engaging in unfair methods against consumers and other producers.

The granting to a certain organization of the exclusive right to render a given kind of public utility service in a limited territory carries with it inherent evils. There is always a danger that the utility will abuse its privileges to the public detriment. These possibilities of evil are held in check, however, by an alert and intelligent public interest, and by a public service commission duly constituted and empowered to require adequate and sufficient service at fair rates. There must be an understanding of the fact that railroads and utilities must be controlled for the protection of one another and of the public.

The early concept of government relations with organizations supplying public service was that competition is desirable and should be enforced if possible. This became the basis of action with respect to railroads until comparatively recent years, when it became partially realized that they are by nature monopolies and form a distinct type of private enterprise. There remained, however, a large element of fear that railroads would combine to the injury of the public.

Beginning about 1870, when railroad competition became active, there was a cutting of rates and discrimination against non-competitive points which rapidly led to a demoralization of railroads. Bitter rate wars were waged, and it soon became evident that, if the unrestrained competition were continued, the roads would be plunged into bankruptcy and hopeless ruin with disastrous consequences to towns and cities, as well. The dangers to public interests were as manifest as those to private. Rates became unreasonable, inequitable and unstable, because the roads were forced to compensate for their losses in competitive areas by charging discriminatory rates in non-competitive territories. These rate wars and their evil consequences were the indirect, if not the direct, cause of public regulation. The experience of this and other countries shows that competition and not co-operation has given rise to the most important phases of the railroad problem, and that public

[1] A study of the situation in Pennsylvania and its control by the Public Service Commission being an analogy between the consolidation of our railroads and of our electric utilities.

interest is served better by proper control over railroad co-operation. This idea of regulation has expanded until today practically every branch and element of railroad service is subject to public control.

MOVE TOWARD RAILROAD CONSOLIDATION

After years of Federal regulation of interstate commerce, the fear of combined action by our railroads has, to a large extent, yielded to a constructive policy of encouraging consolidations along lines which meet with the approval of the Interstate Commerce Commission. Railroads, after passing through many stormy periods, have finally come to a point where they are encouraged to solve their problems of rendering better service at lower costs by combining into a limited number of large systems. This was the principle laid down in the Transportation Act of 1920, when Congress authorized railroads to consolidate according to plans recommended or approved by the Interstate Commerce Commission. That Commission is now engaged in attempting to devise a grouping of roads that will produce unity, greater efficiency, and better service. In this no new economic principle is being expressed; there is only the stamp of public approval placed upon a movement that has been marching on steadily since the advent of the steam locomotive. There is now a more widespread consciousness of the advantage of a unified transportation service. Early consolidations were of connecting lines; present consolidations are of not only connecting roads, but of roads serving different and the same territories.

The Interstate Commerce Commission is confronted today by the stupendous problem of bringing about a consolidation of railroads according to plans which aim to establish more unified, adequate, efficient and economical service. The voluntary combinations among railroads have been based primarily upon profit-making considerations. The public welfare has been incidental and has been injected only through the action of the Federal and state governments and other interested parties.

The Interstate Commerce Commission, in formulating a consolidation program, is between two opposing forces. On one side, there is the desire of each railroad to retain its own properties unless encouraged to consolidate by an opportunity for gain. Coupled with this is the desire of the large systems to acquire only profitable lines or those with profit-making potentialities. If allowed to effect combinations dictated by financial considerations alone, weaker roads, serving sections poor in resources or undeveloped, would be isolated. The advantages of large-scale operation would accrue to rich areas more fully developed and perhaps enjoying competitive conditions; while the poorer territories would tend to remain poor. They at least would not benefit by better and cheaper railroad service as accomplished through large consolidations.

On the other side, there is the fear that certain communities will be deprived of adequate service or suffer from some form of discrimination or neglect. There remains, also, a strong vestige of the distrust of monopoly power. Much of the fear of inadequate facilities and discrimination would be largely dissipated if two decades ago the Interstate Commerce Commission had started to outline and enforce a program of consolidation. A lack of legal power, doubtless, has been a deterrent, but more significant has been government inertness resulting from a failure on the part of the public to envisage

the problem and to prepare for the rising tide of railroad combinations privately conceived and executed.

PROBLEM OF ELECTRIC CONSOLIDATION

This tendency toward the consolidation of railroads has its parallel in a related branch of public utility service —the generation, transmission and distribution of electric current. The combination of electric companies is destined to exert a powerful influence upon social life, and forms an essential part of one of the most significant movements in any private or public enterprise today,—namely, the integration of electric generating, transmission and distribution facilities, or what is more commonly known as "Giant Power" development. From a public standpoint, the advantages of integration of electric companies will be making a cheaper and more convenient form of power more generally available for homes, industries, railroads and farms. This will produce salutary effects in urban and rural life and will result in revolutionary changes in America's most important and basic occupation, —agriculture.

The Public Service Commission of Pennsylvania is being confronted today by the same conditions with respect to electric utilities as confront the Interstate Commerce Commission with respect to railroads. Power companies are spreading out and merging other units. These combinations, privately initiated, are based not upon the best interests of the state as a whole, but are organized according to the interests of the dominant company back of the movement. The Public Service Commission is endeavoring to view combinations of electric utilities from a state and interstate point of view, and is endeavoring to preserve public interests and at the same time encourage legitimate business expansion. The Commission fully appreciates the advantages and desirability of combination in this field, and its plans are predicated upon this idea; but it realizes also that the consolidations must be subjected to careful investigation with a view to determining the economic and general social consequences.

Combinations of electric companies are not unlike those of railroads. The first groupings are of connecting utilities or of those serving adjacent communities which frequently constitute a single economic section of the state. There follow consolidations of large units with a view to tying together generating stations and transmission lines and thus effecting a more unified service. The extent to which this form of combination might be developed is difficult to forecast, but it is evident that the end has not been reached.

That combinations in the production and distribution of electrical energy are being effected at an unprecedented rate, and are assuming large proportions, is evidenced monthly by applications which come before the Public Service Commission for the incorporation, merger, consolidation and purchase of a controlling interest in capital stock of electric companies.

Before presenting statistical data bearing upon the extent or scope of combination, a few brief definitions of terms used will serve to clarify the various methods employed and the reasons why certain legal processes are resorted to.

SIMPLE INCORPORATION

An important forerunner to extending the territory which a utility serves is the incorporation of new companies with franchise privileges to construct and operate power facilities in certain limited areas. These companies are usually brought into existence through simple incorporation. By this term is

meant the organization of distinctly new companies in which mergers or consolidations are not directly involved. Without attempting to engage in an elaborate discussion of legal distinctions, it may be pointed out that there are three types of corporations included in this class—steam electric companies, hydro-electric companies and electric transmission companies.

The part played by simple incorporation in plans for consolidating utilities will be seen from an examination of the statistical information given below.

Steam Electric Companies

The steam electric company is the most common form of simple incorporation, and is organized with the power to manufacture, distribute and supply light, heat and power. For this reason these corporations are usually known as light, heat and power companies.

The Steam Electric Act of 1899 does not designate the manner in which electric current is generated, hence it has been recently ruled by the Attorney-General's Department of the Commonwealth of Pennsylvania that such a corporation may generate its current by either steam or water power. The Steam Electric Act limits the charter territory of a corporation to a borough, city, town or district and the territory adjacent thereto; and it has ruled (*Brown v. Electric Light Company*, 208 Pa. 453) that the term "district," as used in the Act of 1899, in similarity to a like provision providing for the incorporation of water companies, is to be taken as meaning a part of a borough, city, town or township, and that, therefore, a steam electric company cannot be formed for two or more municipalities or for parts of two or more municipalities. The result of these legal restrictions is that recent corporations of this class are usually organized with charter privileges limited to a single township, and are frequently called "township companies."

Hydro-Electric Companies

Hydro-electric companies are in legal contemplation corporations which have been chartered as water power companies, and which are given the additional right to generate and supply electric current from water power.

It appears that water power companies may be organized as local companies enabled to function in a restricted territory, or as companies with broader territorial privileges.

It has been ruled by the Attorney-General that steam electric companies may develop current from water power, but it does not necessarily follow that water power companies may generate current from steam. The law would seem to be the other way, for it is a principle of law that corporations have only such powers as are expressly conferred or necessarily implied by such expressed conference; and since the hydro-electric company is given the right, by statutory law, to generate electricity only by means of water power, this expression of the one manner of generating the current would seem to carry with it a negation of all other matter. This restriction upon the rights of hydro-electric companies has caused them to incorporate steam electric companies where it is desired to augment the supply of current by the construction of a steam generating plant. A recent instance of this has been the incorporation of the Holtwood Power Company by the Pennsylvania Water and Power Company, a hydro corporation. The former company is to construct a steam electric generating station at Holtwood, on the eastern shore of the Susquehanna River, and is to sell and deliver all its current to the Pennsylvania Company. The latter company is to own all

the capital stock of the new corporation.

This restriction of legal powers has caused the legal and other expenses incident to giving birth to a new corporation, and is an unfortunate and useless obstacle to business progress.

Electric Transmission Companies

Electric transmission companies are organized for the sole purpose of transmitting electricity or for tying in of generating stations owned by different utilities. The function of corporations, with the sole authority of transmitting electric energy, is not specifically provided for in the statutory laws of the Commonwealth. They are formed under the Act of 1909, P. L. 515, which authorizes the formation of corporations for any other purpose not otherwise specifically provided for. There are few of these transmission companies in existence, the probable explanation being that there is no statute conferring on them the right of eminent domain, so that the expense necessary in purchasing the right-of-way for the transmission line would be in most cases prohibitory.

MERGER, LONG FORM (CONSOLIDATION)

By the Act of May 3, 1909, P. L. 408, it is provided that corporations of a similar character may merge their corporate entities, and it has been judicially determined (*Penna. Utilities Company v. Public Service Commission*, 69 Pa. Super. Ct. 612) that the effect of such merger is to bring into being a new corporation, separate and distinct from the constituent companies. This form of corporate union is generally known as a "consolidation."

By this process, if companies A, B, C and D are to be combined, a new corporation, X, is incorporated to take over the rights, franchises and properties of the four original corporations. The old companies are automatically dissolved and cease to exist as corporate entities when the new corporation comes into being.

SALES—KNOWN AS A SHORT MERGER

Under an Act of April 17, 1876, P. L. 30, one corporation is authorized to sell its property, franchises and privileges to another corporation. In case of a short merger, no new company is organized, but one of the old companies buys out or absorbs the others. The companies bought out then pass out of existence. Thus, X, a large operating company, might purchase the rights, franchises and properties of A, B, C and D companies, and then dissolve the absorbed entities.

The fundamental distinction between a long and a short merger is that in the former a separate and distinct corporate entity comes into existence, whereas, in case of the latter, the corporate entity of the purchasing, or vendee, company remains *in esse*, while that of the selling company disappears.

INDIRECT FORMS OF CORPORATE UNIFICATION

While the above are the direct methods of effecting a legal unification of electric companies, there are certain indirect processes which are substantially as effective in bringing about unity of corporate relationship, in that they give one corporation the power to control the property or product of another, and, in case of stock control, the power to determine financial, as well as operating, policies. These methods are stock control, lease of facilities, and exclusive contracts for purchase of current.

STOCK CONTROL

As the ownership of stock, particularly the common, carries with it the

right to control the enterprise, the control by one electric company of the stock of another, gives to the vendee company the power to determine the financial and operating policies of its subsidiary or affiliated companies. Under the provisions of the Public Service Company Law of Pennsylvania, such control is subject to the approval of the Public Service Commission.

LEASE OF FACILITIES

By a lease agreement one company may obtain the possession and use of all or a part of the properties of another. The corporate entities are retained and kept distinct. Such leases among utilities are subject to the approval of the Public Service Commission.

SALE OF CURRENT

When one company agrees to sell the entire output of its product to another, there is established a corporate relationship which is practically as effective as the other forms. The contracts binding the corporations are so comprehensive that the companies are in effect united into one.

ANALYSIS OF INCORPORATIONS AND COMBINATIONS OF ELECTRIC COMPANIES IN PENNSYLVANIA

The information upon which the following study of incorporations and combinations is based was obtained from the Application Docket of the Public Service Commission of Pennsylvania. A corporation does not come into being until letters-patent have been issued by the Governor of the Commonwealth; but for the purpose of this analysis the existence of a corporation was dated from the approval of the Public Service Commission.

Simple Incorporations

During the year 1923, 365 new companies were organized by simple incorporation; and, during the first nine months of 1924 (January to September, inclusive) 141 new companies were formed in this manner. During the first nine months of 1923, 300 incorporations were approved. The decline from 300 in 1923 to 141 in 1924 might be due to the fact that the preponderant majority of simple incorporations are of township companies organized for the purpose of acquiring franchise rights in individual townships. Chartered as steam electric companies, their territorial rights are restricted to a single township. A saturation point is being approached, and the time is not far distant when there will be, or will have been, a township company, perhaps existing on paper only, for each township. This, of course, will curtail the rate at which such companies are brought into existence.

Judging by the rate at which township companies are being organized, considerable haste is being manifested. What is the explanation? At the 1923 session of the state legislature, an act was passed constituting the Giant Power Survey Board to make an intensive study of the electric power situation in Pennsylvania with view to outlining a policy for the development of the electric industry. Possibly anticipating some form of territorial distribution, the utilities have lost no time in obtaining franchise privileges indirectly through the media of paper companies.

Of the 363 incorporations effected in 1923, 114 were absorbed, during the year, under the Short Merger Act of 1876, and 41 were merged or consolidated under the Long Merger Act of 1909. During the first nine months of 1924, there were mergers of 119 companies organized in 1923. Eighty of these companies were absorbed under the Short Merger Act, and 39 were merged under the Long Merger Act.

Adding the 119 companies merged and absorbed during the nine months of 1924 to the 155 merged and absorbed in 1923, the total of the mergers of 1923 companies is found to be 274, or 75.5 per cent of the 363 simple incorporations of that year. Doubtless, some of the remaining 89 companies will be merged during the last three months of 1924, and subsequently.

Of the 141 companies brought into existence during the nine months of 1924, 62 were absorbed during the same period under the Short Merger Act, and 5 were merged or consolidated under the Long Merger Act. During the first nine months of 1923, 71 per cent of the mergers were under the former law, whereas, during the same months in 1924, 91 per cent were under this Act. This change in the percentage absorbed by short mergers might have no particular importance, other than that the existing utilities are employing direct mergers rather than first forming new companies to consolidate smaller operating or paper companies. During 1923, for instance, 12 new corporations were formed as consolidations of 90 other companies. During the same year, four of these 12 consolidated companies were absorbed, through short mergers, by existing utilities.

The 67 mergers of 1924 companies do not completely indicate the tendency of electric companies to combine, because the majority of mergers of 1924 companies were of those organized during the earlier months of the year. In other words, for the companies brought into existence during the last months of the period, there was insufficient time for applications for mergers and consolidations to be filed and passed upon by the Commission. This is substantiated by the tables on p. 156, which show the simple incorporations effected during 1923 and the first nine months of 1924, the number of 1923 companies merged during 1923, and the 1924 companies merged during 1924. It is evidenced, further, by the 119 mergers of 1923 companies during the first nine months of 1924.

These tables indicate that distinctly new companies are brought into existence almost solely with the object of their being combined into new companies or for being absorbed by existing electric corporations. The analysis of 1923 companies revealed, further, that only five could be identified as operating companies, the remaining 358 having been brought into existence for the purpose of acquiring territorial rights to serve electric energy. They are for the most part paper companies existing in name only and representing an effort to preëmpt territory for an existing corporation or for one contemplated as a merger of smaller units.

What is the significance of this process and movement? The method is resorted to because electric companies authorized to generate current by steam power may not be chartered to serve more than one municipality. The larger municipal units are already supplied with electric service, and the municipalities without service are townships. In order to reserve for themselves these areas and to defend what they consider their proper electrical districts, the larger utilities are forming these township companies and then absorbing them. If this acquisition of territory is allowed to take place according to the will of the individual utilities, and without being guided by any preconceived public plan and policy, the Commonwealth will become a confused patchwork of franchise territories with no evidence of a design intended to guarantee against duplication of transmission lines and the wasteful construction of generating facilities. As has been pointed out, it is such duplication and haphazard division of

COMPANIES INCORPORATED IN 1923 AND MERGED DURING THE YEAR

Incorporated		Merged During Year	Per Cent of Merged to Incorporated
Period	Number		
First 4 Months	128	73	57%
" 5 "	141	76	54
" 6 "	194	113	58
" 7 "	204	119	53
" 8 "	211	120	56
" 9 "	300	143	47
" 10 "	329	144	47
" 11 "	354	155	44
" 12 "	363	155	43

COMPANIES INCORPORATED DURING FIRST NINE MONTHS OF 1924 AND MERGED DURING THE PERIOD

Incorporated		Merged During 9 Months	Per cent of Merged to Incorporated
Period	Number		
First 4 Months	50	37	74%
" 5 "	84	60	71
" 6 "	84	60	71
" 7 "	93	66	71
" 8 "	138	67	48
" 9 "	141	67	47

territory which must be prohibited as contrary to sound public policy and the economics of public utility operation and regulation. It is to be anticipated that this condition will produce, at no remote time, bartering among the utilities themselves for new alignments of territory. Bargains will be driven according to bargaining power, and there will remain the danger that certain districts will suffer from the absence of service. This can be prevented by action of the Public Service Commission only when the utility is chartered to enter the territory. A constructive legislative enactment, designed to provide service in communities where service should be rendered, regardless of original charter provisions, would be to confer upon the Public Service Commission the power to order electric companies to enter and serve territories for which the utilities are not chartered. This would assure extension of service to the more isolated communities in case the Commission became convinced that such extension is socially expedient and fair.

Mergers – Long Form (Consolidations)

During the year 1923, 90 electric companies were combined to form 12 new units, 11 of which became operating utilities. These 11 companies were formed as consolidations of 57 paper companies and 15 operating. Of the 11 new operating companies, only 9 remain, two having been absorbed dur-

ing the same year by other companies under the Short Merger Act of 1876. One company was reincorporated with a slight change in the corporate name.

An examination of the size of the merged operating utilities shows that four had revenues in excess of one million dollars each, the combined income of these four companies being $5,914,221 in 1922. Two of the merged companies had revenues between $100,000 and $500,000; three between $50,000 and $100,000; three between $5,000 and $35,000; and three with less than $5,000.

During the first nine months of 1924, 48 companies were merged to form five new units, two of which became operating companies; one became a transmission line company; and the remaining two existed as paper companies. The two operating companies represented a consolidation of three paper companies and two operating companies. One of the absorbed operating utilities had a revenue in 1923 of $81,626.75, and the other a revenue of $9,917.67.

As further evidence of the methods used in acquiring territory, one of the companies formed in 1924 by long merger was a consolidation of 32 township companies. This new corporation was later absorbed during the same period by one of the largest operating electric utilities in the state.

Short Mergers

In 1923, 223 companies were absorbed by 31 existing corporations, all of which with one exception were operating utilities. Of the 223 companies, 204 were of the township paper variety and probably organized by the vendee corporations in order to obtain franchise rights. The analysis of companies brought into existence by simple incorporation shows that 114 of the 204 merged companies were organized during 1923.

Four of the absorbed units were transmission line companies, all being likewise paper organizations. Four of the merged corporations were formerly leased by the vendee. The remaining eleven merged companies had been operating utilities. An examination of the merged operating utilities reveals that one had a revenue in 1922 of $578,607; one a revenue of $155,000; one, $90,000; two had revenues between $25,000 and $50,000; and five between $5,000 and $25,000.

In 1924, four of the above vendee companies were absorbed, in turn, by other large operating utilities. Three of these absorbed utilities with revenues in 1923 aggregating $875,744.27, were acquired by a single corporation which itself had a revenue in 1923 of $4,279,379.64. During the first nine months of 1924, this latter company acquired two smaller utilities having a combined revenue of $9,999. This merger is a good illustration of how consolidations are accelerated by the merger of larger utilities and gives an excellent idea of the magnitude of the problem and the complexity of the economic and financial interests and considerations. Public control of these operations is obviously a tremendous problem involving a ramification of questions and considerations. The methods employed by the Public Service Commission in passing upon these combinations will be discussed later.

To make the problem still more involved the vendee company, referred to above, first acquired a controlling right, title and interest in the capital stock of the three large operating utilities. Having obtained stock control, the underlying companies were then legally terminated and their properties made an integral part of the vendee company's system. The vendee company acquired a controlling interest, also, in the capital stock of another electric com-

pany having an approximated revenue of $1,200,000, but this utility has not yet been absorbed.

During the first nine months of 1924, 176 companies were absorbed by 23 existing companies, all of which with one exception were operating utilities. Of the 176 merged companies, 154 were paper companies. A further analysis shows that 62 of the 176 companies were organized during 1924, and 80 were 1923 incorporations. The remaining 34, of the 176 companies, were formed prior to 1923 and it is safe to say that most of them came into existence during 1922.

Two of the absorbed units were transmission line paper companies. Three of the merged corporations were formerly leased by the vendee. The remaining 17 units had been operating utilities, eight of which had revenues of less than $25,000; one a revenue of $28,598; three revenues between $50,000 and $100,000; and the remaining five had revenues between $100,000 and $500,000. As pointed out in connection with the short mergers of 1924, three of the absorbed utilities with a combined revenue of $875,744.27, were absorbed by a large corporation which previously had a volume of business amounting to $4,279,379.64. In brief, during the nine months, three companies acquired seven other companies having a combined revenue of $1,241,634.

CONTROLLING INTEREST IN CAPITAL STOCK

The direct and most secure forms of combination are by long and short mergers. These give the vendee company the ownership and possession of the properties of the merged units and the complete and sole rights formerly held by the defunct utility. But substantially as effective, however, in establishing control, or the right to determine policy, is the ownership of all or a large percentage of the stock of another company. As the ownership of stock carries with it the right to chart the operating and financial course of the enterprise, control is thereby established.

By this method, 5 corporations during the year 1923 obtained control over 18 other companies, 15 of which were operating utilities with revenues ranging from $24,724 to $1,200,000 and having an aggregate revenue of $3,232,178. Two of the vendee companies were organized during 1923 and apparently for the purpose of merging and absorbing other companies and acquiring controlling interest in the stock of utilities. One of these two companies was absorbed in 1924 by another large operating utility. It has been explained, under short mergers, that one vendee company acquired the controlling interest in the capital stock of three operating utilities having an aggregate revenue of $694,411, and, subsequently, during the same year it absorbed these companies by short merger.

During the year 1924, three corporations acquired a controlling right, title and interest in the capital stock of four operating utilities which in 1923 had a combined revenue of $75,052.63. A comparison with the year 1923 shows that the combinations by this method during 1924 were less momentous than during 1923.

CONCLUSIONS ON INCORPORATIONS AND MERGERS

The studies of incorporations and combinations in the field of generating and distributing electrical energy give convincing evidence that the preponderant majority of simple incorporations were of paper companies existing in name only for the purpose of acquiring territorial rights. The fact that of

the 363 corporations organized during 1923, by simple incorporation, 274, or 75.5 per cent, were merged and absorbed by other companies by the end of September, 1924, a period of 21 months, must lead to the conclusion that these small township companies are organized by large operating utilities so that the latter can take over the franchise rights to serve certain areas of the Commonwealth. The time is rapidly approaching when there will have been a township company incorporated for each township in which economic conditions and population encourage or make possible the promotion of such an organization. Most of these units will be absorbed by operating utilities seeking to extend the domain of their electric service.

The analysis of short mergers indicates that there is a pronounced tendency among electric utilities to unite into a comparatively small number of large companies. The usual procedure has been for the operating utility to organize small township and transmission units and later absorb these directly by short merger or indirectly by long merger, the company organized by a long merger frequently being absorbed later by the large operating corporation.

It would be interesting to compare the number of operating electric utilities at the beginning of 1923 with the number at the close of the year and to make the comparison on the basis of revenue. The nearest approach to this information is found in the short mergers for 1923, where it is shown that eleven operating utilities with a combined revenue of $2,209,828 were absorbed by six corporations.

The rate at which combinations are being effected, and the apparent eagerness at times of large companies to absorb the smaller and to preëmpt territory for their own service, have made it imperative for the Public Service Commission to exercise all its legal powers in safeguarding the public interests. There is an imminent danger that a company in its eagerness and desire to expand will be led, or forced, to pay unwarranted prices for the absorbed units, because of the threat of neighboring utilities to penetrate what the first company regards as its logical territory. The smaller company, if it senses the strategic position which it occupies in the development of a large system, can hold off and compel the expanding utilities to bid against one another. There is present a form of aggrandizement which may become threatening to the legitimate development and economically sound policy of an electric company. It is readily seen that the result may be the payment of a price for the absorbed company which is wholly out of proportion to its intrinsic worth.

Other serious evils to be committed are the overlapping of territory, needless multiplying of generating stations involving millions of capital invested, and a wasteful paralleling of high voltage transmission lines. The inevitable result of such circumstances and the payment of unreasonable considerations would be to impose upon any utility, imperialistically inclined, high fixed capital charges which the public would ultimately be called upon to carry through rates to yield a fair return on property.

To guard against such contingencies, the Commission must be well informed, alert and willing to exercise the inquisitorial powers which have been statutorily conferred upon it and which have been made a part of its responsibilities. The Commission is zealous in protecting private enterprise against needless interference, and its administrative policy has been such as to avoid the creation of any barriers to legitimate and healthy growth; but it is equally

zealous in functioning to protect the consumer against forces which would react to his injury. It must be appreciated that the Commission is confronted by a tremendous and serious problem with far reaching influences. The work of gathering the essential information, which becomes the basis of properly guided action, has placed upon the Commission with an inadequate staff, a task of large proportions. The untiring energy of workers with a keen sense of public responsibility and social service has made possible a course of action designed to promote business along economically sound lines.

PASSING UPON APPLICATIONS FOR INCORPORATION AND COMBINATION

In taking action upon applications which come before it for the right to incorporate new companies, to merge and absorb existing utilities and to obtain a controlling interest in capital stock, the Commission is guided by certain administrative instruments in the form of technical bureaus.

As a preliminary measure, the Commission has assembled data bearing upon the present status of the electric utility industry in Pennsylvania. This has included a mapping of the territories served by the various corporations and corporate interests; studies of the population, industries and economic areas supplied; the corporate relations of the utilities; their genealogy; their generating facilities; the voltage of transmission lines; and operating and financial conditions.

When an application comes before the Commission, the petition is given publicity with view to ascertaining if any persons in the Commonwealth have reason to object. If a complaint is filed, there are hearings before the Commission for the purpose of gathering evidence to show why the petition should or should not be granted. Even though no complaints are filed, the Commission might find reason to institute an inquiry on its own motion for the purpose of obtaining relevant facts which are not made available in any other way. The application and testimony, which often contain enlightening exhibits, are then examined by the various bureaus or departments of the Commission.

If there is a proposed absorption or short merger, the application and other information are assigned to the Bureau of Engineering, where a study is made of the production and distribution facilities of the merged utility, and of how this property may be integrated with the present facilities of the vendee corporation. The present territories served by the utilities, their history, population, wealth and economic activities are subject to review. The construction of connecting transmission lines which might be necessary to tie together the generating stations, and whether or not this would lead to paralleling high voltage lines and duplication of service in the same economic areas; all must be scrutinized and passed upon before a conclusion is reached. The possible abandonment of generating stations and how the resultant loss would be charged is a necessary element in arriving at a judgment concerning the engineering expediency of the enterprise. The apparent reasonableness of the purchase price, as determined from a study of property values, plays a large part in the determination of the Commission, and this information is supplied by the Engineering and Accounting Bureaus. Paramount to all other matters is the question of the effect of the consolidation on the service being rendered and to be supplied. This involves considerations of the adequacy of the service, extensions, possible economies and the effect upon rates.

The Bureau of Accounts and Statistics examines the application and testimony from a financial and accounting point of view. Studies are made of the financial condition of each utility involved. Analyses are made of operating revenues and expenses, operating and other ratios which give evidence of operating conditions, and the classes of consumers as shown by the details of revenue and other sources. The gross revenue, net income, fixed charges and capitalization are considered in connection with the proposed purchase price. The financial plan in obtaining control is carefully scrutinized. If securities are exchanged, the classes and respective amounts, market price, book value of stock, income security margins, and exchange basis must be ascertained. Any trace of inflated capitalization must be discovered. These figures are compared with those of other utilities when similarities make such comparisons fair and enlightening. There is kept in mind the possible increase in volume of business and net earnings which might result from the merger and large scale operation.

The Legal Department of the Commission reports on the validity of the merger, and the legal rights of the utilities; and is of inestimable value in helping to focus Commission attention on vital problems.

After the technical and professional departments have rendered their reports, the ultimate judgment resides with the Commission. Aside from the purely technical questions, the Commission must decide with reference to what will be sound public policy. The merger might receive the approbation or disapproval of the engineers, accountants and lawyers, but other considerations might swing Commission judgment one way or the other. Usually, however, the final opinion is supported by the findings of the Commission's staff.

The impression is not to be formed that the Public Service Commission has laid out definitive plans for the allotment of territory and the merger of electric companies. Economic conditions within the state are changing, new centers of population are developing, the industrial world is not fixed, rural conditions are giving rise to new power problems, and the advancement in the art of generating and distributing electric energy is in turn reacting upon manufacturing, transportation, mining and farming. In a word, the flux of the elements entering into the power situation makes the formulation of a consummate power program difficult. Electric energy is but one of the factors entering into productive processes and modes of living. As the other elements change, power development will take on new forms and aspects. Electricity in turn is destined to exert a powerful and profound influence upon a wide range of human activities of the future as it has in the past. Evolution in forms of power and methods of power generation and distribution has taken place hand in hand with social evolution in a general sense. In fact, it has been one of the most vital and significant forces in the progress of mankind from dependence upon his own strength and brawn to dependence upon forms of mechanical energy which are the product of the mental resources of the human race. Truly, this is a basic product and manifestation of social progress.

What is needed above all in dealing with the electric power situation is that openness of mind by which improvement has been made possible. There must be developed attitudes and interests, based upon an understanding of the forces and motives at work, which will lead to an enlightened public conception

of the problems before the Public Service Commission and the electric utilities.

The Commission has basic principles with respect to the development which is taking place, but their application will not be subject to hard and fast rules or be administered along inflexible and undeviating lines. Programs and their enforcement are bound to change, but there will remain as a fixed star the obligation upon utilities to evolve their plans in consonance with better, more adequate, more efficient, and economical service to patrons. Combined with this must be the removal of obstacles to legitimate business expansion. A failure of the utilities and the public to follow these principles will not redound to their welfare.

The spirit expressed by the electric utilities of this Commonwealth in their relations with the Commission gives abundant reason to expect forward moving conduct, animated by a desire to co-operate for the public good. The responsibility of the public is to become informed, to be sympathetic, and to remember that the price of liberty, economic as well as political, is eternal vigilance. Only in this way can be found an ethical and sound basis for our civilization.

Power and Interstate Commerce

By Philip P. Wells
Deputy Attorney General, Commonwealth of Pennsylvania

THE rapid advance in the art of high tension electrical transmission has caused experts in the electrical industry to forecast the evolution of regional electric power districts, each embracing many states, each giving practically universal electric service on equal terms throughout its area and all interconnected to form a system covering the whole nation. [1]

Although this forecast takes little account of the several states, the structure of our government and the powers and duties of the states in the matter of public service regulation require us to give them a prominent place in such a national power system. We may, therefore, distinguish four unit areas as follows:

(1) The local areas of retail distribution within each of which power will be served direct to consumers;
(2) The state;
(3) The regional district embracing two or more—possibly many—states;
(4) The nation embracing all the regional districts.

Need For and Future Development

Turning from forecasts to achievements we find that the high voltages attained in recent practice make possible the transmission of large quantities of power across state lines, but circumstances have thus far kept the quantity at a minimum. Perhaps the longest lines of very large capacity from generating station to market have been on the Pacific Coast. In California the urgent need for power and the absence of coal deposits drove the cities of the coast and inland valleys to the water powers in the distant fastnesses of the Sierras. San Francisco and Los Angeles were thus supplied, beginning some twenty years ago. About 1912 the failure of a market, due to the working out of the gold deposits in western Nevada, forced the building of a 110,000 volt line 240 miles long across mountains and deserts to San Bernardino from generating stations on Bishop Creek in California near the Nevada line and nearly due east from San Francisco. At San Bernardino the power is profitably distributed and in part wholesaled for distribution still further south. A line of that length in the East might easily cross the territory of four or five states, but this one was lost in the immensity of California. The vast size of the western states has minimized interstate transmission despite the long lines there in use. The placing of great steam generating stations in the densely populated load centers of the Northeast has had a like effect in this region up to this time. Thus, in 1922, Pennsylvania exported less than 7 per cent of its output and imported a quantity but slightly more than 8 per cent of its output.[2]

But this condition cannot last if present tendencies are to have free scope. The 220,000 volt lines, already achieved, and the 330,000 volt lines

[1] Baum: *Atlas of U. S. A. Power Industry*, McGraw-Hill Book Company, Inc., 1923.

[2] Output 4,238,260,351 kw.h.; with exports, 284,547,200 kw.h. and imports, 342,047,831 kw.h.

indicated for the relatively near future, together with the location of generating stations at the mine's mouth and the harnessing of distant water powers, clearly indicate a vast interstate commerce in electric current in the near future. The manufacturers of southern New England, for example, are keenly alive to the great hydro-electric possibilities in the development of the St. Lawrence-Great Lakes Seaway and are making their plans in reliance on this source of energy. In short, all signs point to a course and extent of development analagous to that which took place in railroading during the last century. While we are still on the threshold of this development the time is propitious to take stock of the situation and to plan wisely for the future. The blunders, waste and abuses of the era of railroad expansion should be avoided.

STATE OR FEDERAL JURISDICTION

The question of Federal jurisdiction over interstate transmission of electric current for power has not yet come prominently forward in the courts. But it is destined to come forward soon and the manner in which the courts will deal with it, if development continues along the lines of present tendencies, is clearly indicated by principles firmly settled in cases dealing with other matters.

In *Western Union Telegraph Company* v. *Foster*, 247 U. S. 105, the Federal Supreme Court held void an attempt by Massachusetts to compel service to certain firms in that state of telegraphic news of sales and prices on the New York Stock Exchange, this on the ground that such electrically conveyed information was interstate commerce and therefore beyond the reach of state regulatory power.

Decisions dealing with the transportation of oil and gas by pipe-line across state boundaries are pregnant with prophecy as to the law of interstate transmission of electric energy by wire. Mr. Justice VanDevanter, in giving the opinion of the Court in *Pennsylvania* v. *West Virginia*[3] in 1923, said:

> What may be done with one natural product may be done with others, and there are several states in which the earth yields products of great value which are carried into other states and there used.

This case held void a West Virginia statute requiring all persons and corporations serving the public in West Virginia with natural gas to fill at fair prices all demands from West Virginia before exporting any gas across state lines. Large populations, industries and public institutions in Pennsylvania and Ohio were dependent for heat on natural gas from West Virginia and had been so dependent for many years. These states therefore brought suit to prevent the enforcement of the West Virginia statute. The Court held the statute void as an attempt by a state to regulate interstate commerce, and an injunction prohibiting its enforcement was granted. An earlier case (*West* v. *Kansas Natural Gas Company*, 221 U. S. 229) had held void an attempt by Oklahoma to prohibit the export to other states in ordinary commerce of natural gas produced in Oklahoma. But the Pennsylvania-West Virginia case went further and extended the same principle to prohibit attempted restrictions by West Virginia upon export by public service corporations peculiarly subject to state regulation.

Notwithstanding the vigorous dissent of Justices Holmes, McReynolds and Brandeis in the Pennsylvania-West Virginia case, we may take the law to be settled on the following points: (1) A general prohibition by a

[3] 262 U. S. 553.

state against export to other states of any of the products of its natural resources is void; and (2) a requirement imposed by a state upon its agencies furnishing in public service any product of its natural resources, that they give preference to consumers within its borders over consumers in other states, is void as against an established business of furnishing the same to consumers in other states.

The possible dangers to the people of all the states inherent in this state of the law are indicated by the case of *Missouri* v. *Kansas Natural Gas Company* decided by the Supreme Court last May. In that case the company developed and purchased natural gas in Oklahoma and Kansas, which it transported by pipe line into Kansas and Missouri respectively and there sold at wholesale. The company raised its sale prices and the states of Kansas and Missouri attempted to reduce the rates by regulation. This resulted in suits in the Federal courts in both states and in the state courts of Kansas. The Supreme Court of Kansas held that, although the business was interstate commerce, the receiving states could regulate it unless and until Congress sets up a system of Federal regulation. The two Federal courts held the contrary. The United States Supreme Court reversed the Supreme Court of Kansas and affirmed the decrees of the two Federal courts. It follows that the transmission of electric power across state lines for wholesale delivery in the receiving state cannot be regulated by the state public service commissions, notwithstanding the fact that the Federal Government neglects to regulate it.

DO WE WANT FEDERAL REGULATION?

Nor is the prospect of Federal regulation as a stop-gap inviting. The court (Mr. Justice Sutherland) did, to be sure, say that if the delivery had been at retail in the receiving state the local interest would have become dominant and the business therefore subject to state regulation until Congress had begun to regulate it, citing *Pennsylvania Gas Company* v. *Public Service Commission*, 252 U. S. 23. In that case regulation by the state of New York of the rates charged consumers in Jamestown for natural gas delivered directly from mains which brought it into the state from Pennsylvania was, in the absence of regulation by Congress, held to be valid. Quoting the *Minnesota Rate Case* the court said:

> Congress must be the judge of the necessity of Federal action. Its paramount authority always enables it to intervene at its discretion for the complete and effective government of that which has been committed to its care and for this purpose and to this extent to displace local laws by substituting laws of its own.

The gas business in question was held to be local in its nature, "similar to that of a local plant furnishing gas to consumers in a city," and therefore subject to local regulation until Congress undertakes to regulate. That business was, therefore, not analogous to the coming universal electric service to the entire area of a region covering many states and interlocked with other such regions into a nation-wide system. The coming universal electric service may well grow into one of "those subjects which require a general system or uniformity of regulation" as to which the court has said, that "the power of Congress is exclusive" (*Minnesota Rate Cases*, 230 U. S. 352, 399). And even if not exclusive, the authority of Congress is dominant if invoked, and our experience with railroad rates shows that it may be invoked.

That experience, as well as the possibilities of manipulation through intercorporate relations, sounds a warning

against complacent reliance upon salvation from Washington. If it is attempted at all it may have to be extended at last to interstate deliveries at retail. When the interstate transmission of electricity from Giant Power generating stations in the coal fields of Pennsylvania and from the great navigation dams in the St. Lawrence has become the order of the day, shall every man's light bill be regulated from Washington? If not, can even wholesale interstate deliveries be well regulated there, in view of the nation-wide network of transmission lines forecast by Baum's *Atlas?*

As Governor Pinchot has said:

> The freedom of commerce among the several states, the unrestricted exchange across state lines of services, goods and resources guaranteed by the Federal Constitution, is the strongest man-made basis of the prosperity of each state. This consideration applies not only to energy riding in a coal car, but equally to energy flowing over a wire, whether the burning of fuel or the falling of water was the source.
>
> Such a system must transcend state lines, and is likely to become nation-wide. The new art of electric transmission is already so developed that the Giant Power system with which we are immediately concerned should now include all power producers and consumers in the northeastern section of the United States and should perhaps draw also upon resources of water power in Canada.
>
> If this is so, then Pennsylvania should share its fuel power with southern New York, and New York should share its water power with western Pennsylvania. I hope and expect that the power resources of Pennsylvania will be intensively developed, enormously increased, and their product greatly cheapened, not only for the people of Pennsylvania but also for the people of New Jersey and New York.

NEED FOR CO-ORDINATION

It seems clear that the circumstances call for the co-ordination of Federal and state authority and for the harmonious co-operation of the states so that electric current, whether from water power or steam power, will be turned over to the distributing units in the receiving states free of any excessive costs. The regulatory authorities there will then be able to give adequate protection to the consuming public. With respect to water power within Federal jurisdiction, estimated to be more than 75 per cent of the total water power resources of the country, a basis for such co-operation is secured by the conditions embodied in the Federal license disposing of the natural resource. These limit the license to fifty years and establish the actual net investment as the recapture price and as the rate-base for state regulation. Only in case two states disagree as to the regulation of a licensee doing an interstate power business between them does the Federal Power Commission have the authority and duty to regulate.

When coal burned in Giant Power plants in the coal fields is the source of cheap electric current used in public service, the Federal Government has no jurisdiction over the disposal of the resource. It, therefore, falls to the producing state to see to it that the power is delivered to local distributing units free of excessive cost, and, as to such units beyond its own borders, that they be given no advantage over its own people.[4]

This duty is obviously reciprocal and calls for an agreement between the states concerned. Failing such agreement a producing state like Pennsylvania, rich in exhaustible fuel power, but poor in perpetual water power, would be well advised to withhold

[4] It is alleged that failure to foresee and guard against such an outcome has resulted in German, French and Italian industries securing current developed at water from sites in Switzerland at rates lower than those paid by their Swiss competitors.—THE EDITOR.

grants of its sovereign powers whether by incorporation, eminent domain or otherwise, in aid of the exportation of its natural power resources to any other state refusing equal and reciprocal advantages with respect to its natural power resources. The stability which such an arrangement needs could best be supplied by a compact between the two states consented to by Congress under Article I, Section 10, paragraph 3, of the Federal Constitution. Failing this the regulation of interstate transmission and distribution of electric power seems destined to fall under direct Federal administration.

For the simplification of the problems of regulation as to interstate commerce in electric power, it is suggested that the corporate structure of the business, so far as it is conducted in large volume by private enterprise in public service, be segregated into three parts, generation, transmission and distribution, each conducted by a separate corporation. Generating, transmitting and distributing corporations serving substantially the same communities should be allowed to hold each other's stock without limit. Service from the generating to the transmitting company and from it to the distributing company should be subject to state public utility regulation. Interstate commerce should be confined to transmitting corporations and be regulated by agreement of the states concerned as above stated.

By agreements of this character regional districts embracing many states could be built up with a minimum of reliance upon Federal action in a matter touching intimately and directly the lives of multitudes of citizens in all communities throughout the conference. It would then remain to provide for the interconnection of these districts for the interchange of power among them. Perhaps, when this stage of development has been reached, it may be found that the task of regulation requires direct Federal action.[5]

[5] Baum (*Atlas*) suggests one regional power company to conduct interchange of power throughout each of the twelve regional power districts into which he tentatively divides the United States. Interchange among these districts would then be a matter of arrangement among the twelve regional power companies. He does not discuss the problem of regulation.

Is Giant Power a State or Federal Utility?

Should Its Control be Through Public Ownership or Regulation?

By Alfred Bettman

Attorney-at-Law, Cincinnati, Ohio

THE issues between public and private operation of public utilities are usually discussed as though a decision could be made on the basis of a theoretical or abstract comparison of the relative advantages and disadvantages. The concrete problem of whether a particular community should take over an existing utility is, however, seldom as simple as that; and, in fact, the factors which the previous history of the community and of the utility throw into the problem might well, and generally do, out-weigh in difficulty and decisiveness the abstract factors which would determine the solution if an entirely new utility or new community or both were involved. The taking over of an old and existing utility with its accumulation of past history and habits might sometimes be considered too costly, even though it be granted that public operation is, other things being equal, a wiser mode of operation.[1]

Experience with all types of public utilities, both local, such as street railroads, and national, such as steam railroads, has demonstrated that, in the course of development and operation, there grow up vested interests and habits and mental attitudes exceedingly hard or costly to destroy or purchase away and which, in fact, are never entirely destroyed or purchased away but hang over into a changed status, as for instance, the change from private to public operation. We have always with us, for example, the most obvious and yet powerful type of interests, represented by the private capital which has been invested or claimed to have been invested and the innumerable collateral relationships established by and with that capital, such as the stockholders, bondholders, holding companies, bankers. This particular type of vested interest is the most simple with which the change from private to public ownership has to deal, as it is purely a matter of dollars and cents; and the chief difficulty arises from the fear that the dollars and cents may be too numerous for the later success of the public operation.

More difficult to appraise or to remove are the vested habits of mind, so to speak, or the attitudes or emotions which develop on both the public and private sides of the field. Those who operate the utilities and their social and financial adherents get to feel that they alone can do the work well; that the public is incompetent by nature; that all sorts of vague and terrible evils will follow a change to public ownership. Those who have the offices and positions in the operating company fear and tend to resist the abolition of those offices and positions. More subtle than this, and therefore more difficult to remove without over-

[1] Such a general admission would be immediately challenged and with the factual data at hand would with difficulty be defended. This comment is made without regard to the equities involved and simply to put our readers on guard as to any easy acceptance of dogmatic statements either for or against public ownership or public operation of utilities. As pointed out elsewhere, this volume has at best an indirect bearing on this group of questions.—Editor.

coming much resistant residuum, are the attitudes reflected in the statutes and judicial decisions, where inevitably, along with general principles of progress, there grow up healthy and pugnacious reservations concerning the rights of things as they are. Equities grow up which create moral obligations to continue to recognize, to some extent, that which the community has permitted.

These observations apply to the public's side of the field as well. If the utility began as a purely local matter within the confines of a single municipality, vested interests in local regulation, so to speak, grow up and resist a change to state or national regulation, even when the utility has come to be a part of a metropolitan or interstate industry. The local regulating officers and boards become proud and fond of their positions or grow to believe that they alone can do the work well. Points of view, habits of thought, atmospheric conditions come into life and grow strong, such as the fear that if the regulation be removed from the locality to the nation, the transfer produces not only a decrease in efficiency but also grave dangers to the national life. These points of view or attitudes become incorporated into the statutes and judicial decisions, which rather toughly resist a change.

The changes when made are never a clean slate. All the previous history and previous mental habits and moral reactions leave a residual deposit which complicates and reduces the effectiveness of the later modes of regulation or operation. If the recognized capital be excessive, the excess capitalization must be more or less permanently preserved. In the process of changing from less to more regulation, private to public operation, local to state or national regulation, the attitudes or opinions of those persons, whether private or official, who owned or operated or regulated the utility tend to retard and complicate the free, unhampered, logical application of the newer theories or modes of ownership, operation or regulation. Legislation and judicial decisions retain some of the older ideas or principles. In short, the change or transfer is burdened with paying off the costs of the accumulated vested interests and of the personal, official, legislative and judicial points of view.

The lesson of all this is, that when we have an opportunity to think out the problem of a new type of public utility, such as Giant Power, it is wise to learn from experience and to exercise imagination enough to realize from the beginning whether we are dealing with a local, state or interstate institution or one which can be more effectively managed by public or private ownership, public or private operation, local, state or national regulation; and then to have the intelligence and boldness to formulate, frame and put into effect those modes of ownership, operation and regulation which, from the point of view of public welfare, are most appropriate to the type of institution which is in process of being born and organized.

A NATIONAL PUBLIC UTILITY

Other papers in this volume will demonstrate that Giant Power is not a local utility or even a state utility, but that while not a national utility in the sense of one unified national enterprise like the telegraph, it is with some relatively unimportant exceptions, inevitably, when considered from the point of view of economy and efficiency and public relations, an interstate utility. The location of the sources of the power, namely, waterfalls and coal mines, the topographical layout of the power-producing districts, the logic of

the facts of transmission economies, demonstrate that the appropriate territorial integrations point conclusively to districts which have no relation to and pay no attention to state boundary lines. If Giant Power is to render its possible maximum service to the nation, and with the least detriment to national welfare, it must be envisaged, dealt with and prepared for as a national public utility; for under our federal form of government and the commerce clause of the Constitution of the United States, that which is interstate is national.

The lesson to be drawn from railroad regulation particularly, and to some extent from other utilities, both national and local, is that if we proceed in the case of Giant Power upon the principle of muddling through, of trial and error, of one little step at a time and the like, and permit each small possible power district to organize itself as a separate economic and legal community, whether with public or private capital, public or private operation, or each state to treat itself as the economic and legal unit, whether the unit be that of plant investment or the unit of operation or regulation, we will impose upon this new and vital utility the handicap of the accretion of various types of vested interests in capital and personal power and of the various mental attitudes of owners, operators, legislators, regulators, courts, which will make it more costly or even prohibitive to take those future steps toward treating the industry as interstate or national, which sooner or later the logic of the economics of the industry will show to be advisable. This type of utility is still sufficiently young to prevent this accretion, if we but have the courage and imagination to think out the problem in its entirety and to act accordingly.

At the very outset of the discussion of the points raised here, we will meet with an attitude of mind quite common at the present time, namely, the fear of an increase of Federal power and its effects both upon national efficiency and local government. To some extent this fear is the result of the habit of over-centralizing the administration of almost everything of which the national government takes charge. Neither the subject-matter nor the physical limits of this particular paper permit a discussion of proposals whereby the administrative organization of a national Giant Power system could preserve the efficiency of the industry on a national scale and at the same time avoid excessive centralization at Washington and give ample play to local information, local talent and local interests. It is surely quite possible to so arrange the administrative organization, whether of national public ownership, public operation or public regulation, as to utilize the knowledge, talents and enthusiasms and protect the interests of the various portions of the country in which the power-producing or power-consuming districts would lie. Whether the best method would be local administrative districts or local corporations organized by the national government or other modes cannot be fully discussed here. Perhaps the states themselves might be the local administrative organs. If, as is now proposed to some extent, the defining of the districts and the district administration be arranged by treaties between the states, possiby a similar device, namely, treaty between state and nation, might be developed; and if, as would seem to be inevitable, the need of national control or regulation will sooner or later become obvious, then the treaty between state and nation has this advantage, that should a change in state politics or opinion produce a default on the part of the state

in the performance of its treaty obligations, the Federal Government would be in position to take charge of the situation and produce some continuity of administration.

Legal Status of National Control

This paper is introductory in its nature, and one of its main purposes is to present some of the legal aspects of the problem which support the above hints. The decisions of the courts upon gas, electricity and railroads point unmistakably to the conclusions: that Giant Power is a public utility and as such is subject to public ownership or public regulation; that to the extent that Giant Power is interstate, that is, transmitted across state lines, it is a Federal public utility and subject to as much Federal ownership or Federal operation or Federal regulation as the nation, acting through Congress, may determine; that in so far as any Giant-Power district crossing state lines can, from the point of view of economy of production or distribution or of justice to and equality amongst the consumers of the power, be best promoted by treating a district as a unit, in that far the intrastate production and transmission of or within that unit is as fully subject to Federal control, whether through ownership, operation or regulation, as is the interstate production, transmission or distribution; and that in so far as the production, transmission or distribution is interstate, the power of the Federal Government to control or regulate tends to be held by the courts to be exclusive, so that state control, whether by a single state or a combination of states, tends toward being more or less excluded from the field. The great lesson of the development of these judicial doctrines is this: that as the economic need of treating an industry as national or interstate becomes more pressing or obvious with the result that either the industry itself or the public presses for increasing Federal control, the law gradually develops toward a more and more exclusively national power of control. As the economics of Giant Power production, transmission and distribution, and the problems of reasonable and equitable rates and service, come to dictate integrations into units or districts which cross state lines, the history of our constitutional law indicates that the law concerning Giant Power will rapidly tend toward an exclusively Federal power of regulation and that state regulation through state law will prove an inadequate instrument upon which to rely for the protection of the public or for the development of a permanent Giant-Power program.

As this is not a law textbook, no effort will be made to describe fully the development of the principle of Federal control over interstate utilities or to cite all cases. A rough summary will suffice here.

The judicial decisions are clear to the effect that, for instance, gas produced by a producing company or transmitted through pipe lines owned by a pipe line company is a public utility and subject to all the regulations to which public utilities are subject, though neither the producing company nor the transportation company sells to the ultimate consumer and though distributing companies be the sole consumers. There can be little doubt that the courts will sooner or later treat this problem realistically and hold that as the quality of gas which the householder in southwestern Pennsylvania uses for lighting and heating is particularly dependent on the quality of gas produced in West Virginia and sent through the pipe lines from West Virginia to Pennsylvania, and as the price which the householder pays for that gas is dependent upon the price which the West Virginia produc-

ing company receives for that gas from the distributing company, therefore the producing company and the transportation company are as much public utilities or parts of public utilities as the distributing company. In *Public Utilities Commission* v. *Landon*,[2] the court held that local natural gas distributing companies were local, not interstate and that their rates were subject to state regulation; but the court clearly stated that the transportation from the wells across state lines to the mains of the distributing companies was interstate commerce.

Pennsylvania Gas Company v. *Public Service Commission*[3] held that gas which is produced in Pennsylvania and sent into New York is an interstate product and would be subject to Federal rate and service regulation. The series of court cases dealing with railroad rates, beginning with the Shreveport case,[4] through *Railroad Commission of Wisconsin* v. *Chicago, B. & I. R. Company*,[5] down to the most recent case of *Dayton-Goose Creek Railway Company* v. *United States*[6] dealing with the so-called recapture clause of the Esch-Cummins law, establish the proposition that, in so far as the intrastate portion of the business of producing, transporting or distributing a utility is so intimately connected with the interstate part that the effective regulation of the interstate part in the interest of reasonableness of rates, non-discrimination amongst consumers, etc., cannot be obtained without controlling the intrastate part, then the latter falls within the constitutional scope of Federal power. This means, of course, that the Federal Government has as much control over every phase which is integrally related to the interstate phases as it would over the interstate phases themselves. The court recognizes that when a utility is or may be logically treated as a national system, the control is also national. "Effective control," said the court in the above-cited Wisconsin passenger rate case, which gave the Federal Interstate Commerce Commission the power to require intrastate rates to be lifted to a level which would not discriminate against interstate rates or impair the interstate rate system,

> effective control of the one (interstate rates) must embrace some control over the other (intrastate rates) in view of the blending of both in actual operation. The same rails and the same cars carry both. The same men conduct them. Commerce is a unit and does not regard state lines, and while under the Constitution, interstate and intrastate commerce are ordinarily subject to regulation by different sovereignties, yet when they are so mingled together that the supreme authority, the Nation, cannot exercise complete effective control over interstate commerce without incidental regulation of intrastate commerce, such incidental regulation is not an invasion of state authority or a violation of the proviso.

The court, in passing on the objections raised by the state utility commissions to this invasion of their field, most explicitly states that the national power is supreme in this field.

This conception of a national utility as an integrally national unit to be regulated as a unit and by the nation received even more explicit and inspiring statement in the above-cited case dealing with the recapture clause, which required a small local Texas railroad, the predominant part of whose business was intrastate, to contribute from its earnings into the national pool whereby the earning power of all the railroad companies of

[2] (1919) 249 U. S. 236.
[3] (1920) 252 U. S. 23,40.
[4] (1914) 234 U. S. 342.
[5] (1922) 257 U. S. 563.
[6] (1923) 263 U. S. 456.

the land are to be equalized, as a method whereby rates may be effectively regulated. "Congress," the court stated, "is dealing with a unit in which state and interstate operations are often inextricably commingled."

The states struggled against each of these decisions. Every factor, economic, political or geographic, in this evolution of a national railroad system nationally controlled, will be found, either in analyzing projected Giant Power systems or in future costly experience, to apply to Giant Power.

California v. *Pacific Railroad Company*[7] with many cases therein cited, and many statements scattered throughout the decisions of the Supreme Court of the United States, clearly establishes the principle that the Federal Government has the power to construct and own those enterprises over which, if privately constructed and owned, it would have the power to regulate and control. In the recapture clause case, the court reaffirmed the national power to construct interstate highways, as an essential corollary of the national power over interstate commerce. Perhaps no simple and complete expression of the principle will be found in the decisions; but the logic of what the Supreme Court of the United States has said is that the Federal Government may construct and operate, either directly or through corporations created by it, such as the Emergency Fleet Corporation, those public utilities which are so Federal or interstate in their nature that, when privately owned or operated, they are subject to Federal regulation under the interstate commerce clause. It will thus be seen that the decisions of the courts indicate that, in the case of Giant Power, which is in its nature interstate, the Federal Government has the constitutional power to construct, establish, operate or regulate the whole present or future Giant-Power industry, except only those exceptionally small districts, if any such there be, which are not capable, from either an engineering or economic point of view, of being part of an integrated district which crosses state lines.

The legal basis for treating the problem as a national one exists; that is, there is nothing in the Constitution of the United States, as interpreted by the Supreme Court, which need cause any hesitation or timidity about entering into a survey of the possibilities of treating Giant Power as a national industry or even in framing at the very beginning a national as distinguished from a state policy.

More than that. The judicial decisions already indicate the inadvisability of relying on state, as distinguished from national, control, and the practical, because constitutional, impossibility of effective state control. In the case of *West* v. *Kansas National Gas Company*,[8] the court invalidated an Oklahoma statute which sought to prevent the transportation of natural gas out of Oklahoma, where it was mined. The court declared without reservations that transportation of gas across state lines is interstate commerce, that "in matters of interstate commerce there are no state lines," and that the states may not interfere with such interstate commerce. Similarly in *United Fuel Gas Company* v. *Hallanan*,[9] the court held the production of natural gas, a considerable part of which was destined to cross state lines for distribution in other states, was itself a part of interstate commerce and not subject to state taxation. And in the most recent case on the subject, *Com-*

[7] 127 U. S. 39.

[8] (1911) 221 U. S. 229.

[9] (1921) 257 U. S. 277.

monwealth of Pennsylvania v. *West Virginia*,[10] the court held void a statute of West Virginia which sought to give West Virginia consumers a preferential right to gas produced in that state as against consumers in the neighboring states of Ohio and Pennsylvania, and, after declaring the transmission of gas to be interstate commerce, used the significant expression: "In the matter of interstate commerce we are a single nation—one and the same people." State conservation of the state's natural resources was emphatically held to be no sufficient basis for state control over those resources which flow or may flow in the stream of interstate movement. Quoting from an earlier case (above-cited West case), the court added: "In such (interstate) commerce, instead of the states, a new power appears and a new welfare, a welfare which transcends that of any state."

All of these principles and attitudes obviously apply to electric power in the transmission of which state lines are actually crossed or where the districts dictated by economic considerations would logically cross state lines. The court decisions indicate the precariousness of relying upon state regulatory laws to bring about effective control. If New York and Pennsylvania should succeed in arriving at co-ordinated legislation and administration over a power district which included some Ohio territory, Ohio might come along and upset the treaty;—or the Federal Courts or Federal Government might over-rule or supplant the service and rate standards or the administrative organization established by the two states, even though the whole district lies within the boundaries of the two states.

Public regulation of privately-owned utilities is difficult. It does not succeed thoroughly except where the public equips itself with a regulating apparatus which enables the public to have almost as detailed and comprehensive a knowledge of all the operating, financing and service problems as the operator himself, and where the public is willing, as it generally is not, to employ as able accounting and other technical talent as the operator himself. Regulation through operation is easiest and most effective. Public operation of utilities may have disadvantages; but in so far as regulation itself is concerned, no one could dispute that the regulation of a utility is most complete and therefore most effective when the regulator is also the operator.

Regulation through ownership and contract, such as lease, is easier and more effective than regulation exclusively through law. It is always less difficult to regulate the conduct of one's subordinate official or employe or tenant than the conduct of a completely independent non-contractual party. Regulation by law alone can never quite catch up, so to speak; for each step in the growth of regulation produces in turn the necessity for some further step, and the further step is always, as things go in this world, considerably retarded. Consequently, at best, regulation will always limp somewhat behind the community's need for protection. In Giant Power, as in the case of every other utility, the question of the policy to be adopted by any particular community is always a complicated one, in which public opinion, the conditions and methods of public finance, the political situation and many other factors play so great a part that uniform abstract statements are apt to be superficial. The most that one can say is that there are degrees of effectiveness of regulation, as, for instance, that regulation through ownership and leasing is more apt to prove satisfactory

[10] (1923) 262 U. S. 553.

than regulation by statute and commission.

At best, considerable time will elapse before a national Giant-Power program can be framed, the necessary legislation enacted and the administrative organization developed. Obviously, therefore, the most wise immediate policy for the states to pursue is to take the steps which will best fit into the future national program and will permit that program to be put into effect and the Giant-Power facilities within the states to be transferred to or placed under the jurisdiction of the nation with the least cost and difficulty. This would seem to point to the acquisition by each state, or to the perfecting by each state of effective control with right and power of easy acquisition, of all sources of Giant Power within its boundaries or, at the very least, of all strategic sources of Giant Power. The states ought not to permit the development within their midst of large and strong private interests in these strategic sources which cannot be later delivered to or placed under national ownership or control without excessive or avoidable costs to the public.

On the Regulation of Giant Power

By Edward W. Bemis
Consulting Engineer, Chicago, Ill.

Giant Power assumes that the generating stations are to be connected by transmission lines of sufficient capacity to permit the flow of current wherever needed and involves, on a comprehensive scale, the integration of facilities such as is now in a minor degree found in the interconnection of power stations of the Edison and other companies of Boston, New York, Philadelphia, Pittsburgh, Cleveland, Detroit, Chicago, St. Louis, and our other large cities.

Both experience and theory, therefore, point to: (1) public regulation—under which nearly all large American cities are now operating—or (2) independent publicly-owned plants combined with public regulation, as in Cleveland and Seattle, or complete public ownership and operation, as in the province of Ontario.

I. Public Regulation

By the Individual State. The necessary conditions for the success or ultimate public approval of the public regulation of Giant Power are:

(1) Limitation of the profits to a fair return on the actual cost less depreciation of the property in use at each period of rate adjustment.

(2) Sale of the current at the same price, considering amount and load factor, to every distributing company, whether publicly or privately owned, within reach of the transmission lines or at the state line to any company transmitting to another state.

(3) High character, intelligence, and an eye single to the public interest on the part of all regulating bodies and courts that may be called upon to pass on regulation matters.

Whether state charters and other forms of state regulation can legally tie down a Giant Power company to a rate base fixed by prudent honest investment, less depreciation, is a question of vital importance which may be differently answered in different states. Furthermore, unless a state commission can and will regulate the price at the state line for those Giant Power companies transmitting beyond the state, the same serious trouble will be experienced as in Ohio and Pennsylvania, where those states are halted in securing a reasonable price for natural gas. This is because producing companies, or, more accurately, drilling, gathering and pumping companies, in West Virginia are permitted by that state to sell natural gas at the state line at much more than a fair return on the actual cost, less depreciation, of the fields, wells, pipe lines, pumping stations, etc., in the producing state.

By the National Government. Just as the national government has assumed control of railroads and oil pipe lines crossing state lines, so in spite of the present reaction against the increase of Federal functions our national government may have to assume control of natural gas and electric transmission lines crossing state boundaries.

Apparently the moment electric current flows over state boundaries and

is sold at wholesale, the Federal authority is the only authority. Under the decision in the Kansas City Gas case, May 26, 1924, the U. S. Supreme Court has held that in the absence of Federal regulation such interstate business remains unregulated.

II. PUBLIC OWNERSHIP

Fullest freedom should be given to cities, states and other public bodies to own and operate generating, transmission and distribution plants under somewhat similar, but probably more liberal, provisions, especially as to indebtedness—as are given under existing Illinois laws.

Whatever be one's views of the wisdom of public ownership with or without public operation, in any particular instance everyone should concede the wisdom of allowing this much home rule and public initiative to any city, or to any group of cities, or to any district or state.

Regulation is more likely to be effective, and thus the demand for public operation will be less, if the safety valve of public operation be left open. Regulating bodies will act more promptly and more in the public interest, and Giant Power, like other utilities, will more readily accept their decisions if the public has always open the alternative of public ownership and operation.

Report of the Board of Directors of the American Academy of Political and Social Science for the Year Ending December 31, 1924

I. REVIEW OF THE ACADEMY'S ACTIVITIES

THE year that has just elapsed has again demonstrated, if further demonstration were necessary, the important part to be played by an organization like the Academy in the education of public opinion. The subjects to which the Academy has addressed itself, both in its publications and at its meetings, have been without exception questions upon which the American people are or will be called upon to make momentous decisions. The members of the Academy may well congratulate themselves upon the record of service during the year that has just come to a close. The fact that the Academy is free from any partisan affiliations and that its purpose is not to further any particular theory or views has been a source of great strength and has deepened the national influence of our organization.

The Annual Meeting, held in May last, devoted to AMERICA AND THE POST-WAR EUROPEAN SITUATION, partook of the nature of a great national conference to which organizations from all sections of the country sent delegates. The publication of the proceedings served greatly to strengthen the influence of the Annual Meeting. The regular sessions of the Academy held during the year were not only well attended, but the wide publicity given to these sessions served to extend their influence.

In spite of the important meetings held by the Academy, our organization depends in large measure on its publications for the growth of its national influence. Your Board therefore desires again to take the opportunity to express its deep appreciation of the devoted and unselfish service of the Editorial Council under the able leadership of its chairman—Dr. Clyde L. King. In the preparation of the special volumes issued by the Academy the chairman of the Council has been successful in securing the co-operation of experts in different sections of the country, and the Board desires to avail itself of this opportunity to express the deep appreciation of the Academy to those who have undertaken to bring together the papers contributed to each special volume.

The Board again desires to impress upon the members of the Academy the importance of establishing a permanent endowment fund for the conduct of the research work of the Academy, and for the construction of a building in which the various activities of the Academy may be housed. The life membership fees have been deposited in this fund, and the members of the Board are most anxious that the Academy endowment should represent the contribution of the members of the Academy who will thereby show their appreciation of the service which the Academy has rendered.

The members of the Academy will recall that at the last annual business meeting a report was made on the plan to establish, as a tribute to the memory of Dr. Simon N. Patten, a special Academy Fellowship for which the sum of Twenty Thousand Dollars was to be raised. Up to the present time $3,379 have been pledged, but it is the hope of your Board that through the co-operation of former students of Dr. Patton and those who were closely associated with him in the early activities of the Academy, it will be possible to complete this fund. It would be difficult to exaggerate the importance to the future of the influence to the Academy of the establishment of fellowships for the conduct under the auspices of the Academy of research in economic, industrial and social problems.

II. PUBLICATIONS

During the year 1924 the Academy published the following special volumes:

The Price of Coal—Anthracite and Bituminous (January).

The Centenary of the Monroe Doctrine (January supplement).

Raw Materials and Foodstuffs in the Commercial Policies of Nations (March).

Competency and Economy in Public Expenditures (May).

America and the Post-War European Situation (July).

The Organization and Work of the League of Nations (July supplement).

Scientific Distribution (September).

The Automobile—Its Province and Problems (November).

III. MEETINGS

During the year that has just come to a close the Academy held the following sessions:

May 16 and 17, The Twenty-Eighth Annual Meeting—America and the Post-War European Situation.

October 24—Our Relations with Japan: With Special Reference to the Recent Immigration Act.

November 22—The Protocol of Geneva and American Foreign Policy.

IV. MEMBERSHIP

During the year 1924 the Academy received 1,275 new members and 130 new subscriptions, or a total of 1,405. The Academy lost 83 members by death; 599 by resignation; and 344 delinquent members and 93 subscriptions were dropped. The present membership of the Academy is 7,531 members and 1,491 subscriptions, making a total of 9,023.

V. FINANCIAL CONDITION

The receipts and expenditures of the Academy for the fiscal year just ended are clearly set forth in the treasurer's report. The accounts were submitted to Messrs. E. P. Moxey & Company for audit, and copy of their statement is appended herewith. In order to lighten the expenses incident to the Annual Meeting a fund of $2,206 was raised. The Board desires to take this opportunity to express its gratitude to the contributors to this fund.

VI. CONCLUSION

During the course of the year the officers of the Academy have had several suggestions from members resident in different sections of the country for the establishment of local Academy centers. Your Board is convinced that the establishment of such centers will greatly strengthen the national influence of the Academy and it is giving careful study to a plan which will make it possible to make such a system effective. To undertake work on this larger scale will, however, involve a much more elaborate administrative organization, and especially the services of an executive director whose entire time and energy must be devoted to this work. Your Board is not quite prepared to recommend this step at the present time, but hopes before the next Annual Meeting to lay before the Annual Meeting definite plans having this end in view.

In conclusion, your Board desires again to make a plea for a more active interest and participation of the members of the Academy in the conduct of the Academy's work. Distributed as our members are throughout every section of the country it is important that every member of the Academy feel a sense of responsibility for the strengthening of the influence of the Academy in the section which he represents. No more effective way of strengthening the Academy's influence could be found. It is with this plea for more active co-operation of our members that the Board brings to a close its report for the year 1924.

EDWARD P. MOXEY & CO.

Real Estate Trust Building, Philadelphia

January 12, 1925.

CHARLES J. RHOADS, ESQ., *Treasurer,*
American Academy of Political and Social Science, Philadelphia, Pa.

Dear Sir:

We herewith report that we have audited the books and accounts of the *American Academy of Political and Social Science* for its fiscal year ended *December 31, 1924.*

We have prepared and submit herewith Statement of Receipts and Disbursements during the above indicated period, together with Statement of Assets as at December 31, 1924.

The Receipts from all sources were verified by a comparison of the entries for same appearing in the Treasurer's Cash Book with the record of Bank Deposits and were found to be in accord therewith.

The Disbursements, as shown by the Cash Book, were supported by the proper vouchers in the form of cancelled paid checks or receipts for moneys expended. These were examined by us and confirmed the correctness of the payments made.

The Investment Securities listed in the Statement of Assets were examined by us and were found to be correct and in accord with the books.

As the result of our audit and examination we certify that the statements submitted herewith are true and correct.

Yours Respectfully,

(Signed) EDWARD P. MOXEY & Co.,
Certified Public Accountants.

AMERICAN ACADEMY OF POLITICAL AND SOCIAL SCIENCE

STATEMENT OF RECEIPTS AND DISBURSEMENTS FOR FISCAL YEAR ENDED DECEMBER 31, 1924

Cash Balance January 1, 1924			$8,435.02
Receipts			
Members' Dues		$34,465.47	
Special Donations		2,206.00	
Subscriptions:			
Individuals	$65.00		
Libraries	1,814.59		
Agents	5,174.98	7,054.57	
Sales		4,727.64	
Securities Sold or Matured		2,957.72	
Interest on Investments and Bank Deposits		6,263.24	
Patten Memorial Fund		1,770.00	
Gain on Sale or Maturity of Securities		42.28	
Sundries		11.05	59,497.97
			$67,933.59
Disbursements			
Office Expense		$4,696.65	
Philadelphia Meetings		4,033.39	
Publicity Expense		9,060.79	
Publication of *The Annals*		29,196.19	
Membership Records		2,397.36	
Sale of *The Annals*		515.27	
Securities Purchased		8,744.17	
Discounts and Collections		23.75	58,667.57
Cash Balance December 31, 1924			$9,266.02
Assets			
Investments (Book Value)			$127,078.28
Cash:			
In Academy Office		$400.00	
In Treasurer's Hands, Girard Trust Company		8,866.02	9,266.02
			*$136,344.30

*The foregoing amount includes all moneys collected for the Patten Memorial, aggregating $2,592.00.

Book Department

CZECHOSLOVAKIA: A Survey of Economic and Social Conditions. Edited by Dr. Josef Gruber, Professor of Economics at the Charles University in Prague. Translated from Czech manuscripts by A. Broz, S. V. Vilma and J. J. Kral. Pp. xix, 256. Price, $2.00. New York: The Macmillan Company, 1924.

This volume contains nineteen sketches of as many aspects of present economic and social conditions in the Czechoslovak Republic written by nineteen different contributors. Population, agriculture, forestry, land reform, coal, water power, industries, foreign trade, commercial and customs policy, railways, the postal service, banking, currency conditions, government finance, labor legislation, social welfare policy, child welfare, the housing question, and crime are discussed; and despite the diversity of the topics and the authorship the book possesses a certain unity. Possibly this is a reflection of the uniformity of the official mind, for practically every contributor is an employe of the government within the field in which he writes. In most instances the subjects are treated objectively. The book is packed with facts and statistics, but in almost every essay the political, economic and social significance of the facts presented is made reasonably clear. It will, therefore, be a valuable handbook for those who wish to gain some understanding of the processes through which Czechoslovakia has made herself the most stable and prosperous of the succession states of Europe. The complete lack of references or bibliography will limit the usefulness of the volume to the more serious student. It is a pleasure to observe that the translators have put the original texts into crisp, readable English.

RALSTON HAYDEN.

SOUTH MANCHURIA RAILWAY. *Manchuria, Land of Opportunities*. Pp. 98. New York: Compiled and published by Thomas F. Logan, Inc.

The advantages of Manchuria are set forth in a very interesting book, *Manchuria, Land of Opportunities*, gotten out by the South Manchuria Railway Company. The development of this ancient land was really not begun until the granting of railway concessions to the Russians, a direct rail connection from St. Petersburg to the Yellow Sea thus being obtained.

Agriculture, fostered and helped by the Agricultural Experiment Stations which have done much to educate the native farmers; an extensive system of afforestation which will in time remedy the present lack of timber in some parts; mining, in which some important work is being done by the Railroad in conjunction with the Anshan Steel Works, form the chief industrial activities of the land.

Figures of trade volume are shown both for the country and for the port of Dairen. These figures are of importance in pointing out growth, and for the period of twelve years, from 1910 to 1922, show an average trade increase through Dairen of 12 million dollars per year, the figures for the whole country showing an average yearly increase in trade of 20 million dollars per year.

Commerce facilities are shown and some information is given on the railway system, waterways, ocean steamers, warehousing facilities and banks.

There is also a description of the operation of the South Manchuria Railway and its allied interests, and among the figures it is interesting to note that the Railway shows for the year 1923 a ton-miles of freight figure greater than the Central Railroad of New Jersey with about the same total miles of track and only 10 per cent less than that given for the New York, New Haven & Hartford, which has three times the mileage of line. The average revenue per ton mile for 1923 was 2.51 cents as against 1.116 cents on Class 1 railways of the United States and the English figure of 2.66 cents.

The South Manchuria Railway operates besides the railway proper, harbors, coal mines, steel works, electric plants, a chain

of hotels in the principal cities, and research bureaus.

The book is closed by a short description of some of the health and pleasure resorts of Manchuria.

E. H.

PRUETTE, LORINE. *Women and Leisure, A Study of Social Waste.* With an introduction by Harry Elmer Barnes. Pp. 225. Price, $3.00. New York: E. P. Dutton & Company, 1924.

It is not often that affairs peculiar to the life of the mass of ordinary women receive the sympathetic, penetrating, and scientific treatment accorded by Dr. Pruette to the problem of what use married women are to make of the free time left on their hands by the industrial revolution. Battalions of facts drawn from many fields of inquiry are marched up, made to stand at attention until the whole array can be reviewed as a basis of conclusion. Historical and anthropological backgrounds, sociological concepts of the division of social labor, census material on the occupations of women outside of the home, recent experience with the part-time work of married women, special inquiries regarding the attitudes of men toward work of married women outside the home, the conscious desires, the attitudes toward home life and careers, and the day dreams of young girls and women, all are mobilized. Each is made to yield its quota for a better understanding of what is both a personal and psychological problem for many women as individuals who must have some new outlets for their energy, and a problem for society which needs to utilize all of its human resources.

While in bare outline this treatment appears somewhat formidable, Dr. Pruette's literary style and bits of humor give one the comfortable feeling of discussing the question with an accurately informed person who has had wide human contacts rather than of wandering alone through the stellar spaces of "pure research."

Whether one is a business man worried with the personnel problems of a force of sales ladies or clerks, a psychologist, Freudian, Watsonian, or Termanian, a social worker, a teacher, a mother, a father, or even a child over twelve years, and he or she starts to read the series of day dreams of adolescent girls given in this book, it is safe to wager that he or she will finish that series, however insistent the interruptions. From the fourteen-year-old whose dreams are described as: "to have a certain boy like me real well. Also to show it." Another is to play the piano in opera. Another is to be an honor student, to the twenty-eight-year-old teacher who wants to be a prima donna, and whose dreams are: "I was the center of an admiring, clever, intellectual group especially brilliant and apt at repartee. Many of the group were men who admired me, the women also admired but were jealous. . . . Another was a picture of a home in which the light burned over the library table. Husband sat beside his newspaper, a veritable nonentity—merely tolerated as a necessary part of the scene. The dominant interest was the children and my activities with their games, stories and crafts,"—the series gives one a peep at the mental furnishings of the rank and file of American girls. The majority who want husbands seem to want them either handsome, brave, kind and sympathetic, or simply as a nebulous means to some social or personal objective such as having a home.

Provided this inside view reflects accurately the mental content of these girls and is a genuinely naïve expression, it does not exactly reassure one regarding the powers of observation or the emotional attitudes of these girls. It does, however, give some good clues to what seem to be the practical realities of life, one of which, it would appear, is that a good many girls, while wanting a highly unreal kind of husband, somehow bring themselves to marry whatever comes to hand. That, perhaps, is another urgent reason why Dr. Pruette's suggestion that toleration and encouragement should be extended to experimentation with the work of married women outside of the home. When the rocket of romanticism comes down as a stick there must be available for women as well as for men other kinds of fire works to give some zest to life and to illuminate new areas of interest.

LEE, JOHN. *Industrial Organization.* Pp. 120. New York: Prentice-Hall, Inc., 1923.

An attempt to survey the nature and growth of industrial organization as it affects the control and administration of human relationships within the confines of one hundred and twenty pages must touch naturally only the high spots.

Before tracing the forms and the problems of the relationships between workers and management in the different industrial countries the author sets forth the twofold development that gives a workable basis for success. This development must give assurance of security both to labor and to capital and give a full opportunity to function to the spiritual sense of mutual dependence between labor and management.

In surveying different countries two important phases are given emphasis. First, the nature and problems of works councils and other forms of administrative control. Second, the part that governmental interference is playing in these problems.

The last two chapters of the book summarize general tendencies and touch upon the fundamental question as to whether legislation or the forces of industrial evolution shall forge the future.

The book though difficult to read in places gives an excellent world-wide outlook. The last two chapters afford excellent reading for advanced students in industry, giving them a bird's-eye view of how the organization of human relationships in industry are moving.

CHARLES REITELL.

FLORENCE, P. SARGANT. *Economics of Fatigue and Unrest and the Efficiency of Labor in English and American Industry.* Pp. 426. Price, $5.00. New York: Henry Holt & Company, 1924.

Mr. P. Sargant Florence's purpose in writing upon fatigue and unrest was to give these phenomena their proper factual bases as well as a really economic orientation. For the technique of their study has been ignored by the economists and so has had to be developed largely as an accessory of the more scientific sort of factory management. This is all very well for the collection of data up to a certain point; beyond that point, however, it needs the more careful and more generalized attention of the economist even to get hold of the proper data. And as for anything beyond the collection of data, the economist's obligation is clear. If he will not work at the problem, it cannot have a solution.

Mr. Florence finds fatigue, inefficiency and unrest in the same places. They are functions of the factory system. And when this truth has been finally acknowledged and only then, are we prepared to mitigate them. How further evidence should be needed to establish this preliminary attitude, it is difficult to see, so careful and exhaustive has Mr. Florence been. Especially in Chapters VI to XII is the evidence fully adduced and considered. But also a Part III of the book is devoted to the provision of new data and the method of its analysis.

The whole background of modern research into inefficiency and unrest—both English and American—is made explicit in this one book. And because of this it ought to serve satisfactorily either for textual reference use in management classes or for a summary of accomplishment for the expert.

REXFORD GUY TUGWELL.

MILLER, SIDNEY L., PH.D. *Railway Transportation.* Pp. 890. Chicago and New York: A. W. Shaw Company.

JONES, ELIOT, PH.D. *Principles of Railway Transportation.* Pp. 597. New York: The Macmillan Company, 1924.

HANEY, LEWIS H., PH.D. *The Business of Railway Transportation.* Pp. 570. New York: The Ronald Press Company.

These are three very good textbooks written avowedly for the use of beginning university classes in railroad transportation.

Haney's emphasis is upon the traffic and

practical side of railroading. Three out of six parts of his book, that is to say, deal with rates and freight traffic arrangements. Most of the discusssion is rather detailed and is evidently intended to benefit the young man or woman who expects to come into business contact with railroads soon after graduation.

Jones' book, on the other hand, is mainly concerned with the features of railroad transportation which have been the subject of public controversy during the last two or three years. He gives much space to railroad legislation, discrimination, reasonableness of rates, over-capitalization, labor disputes, government ownership and similar questions. This is sometimes spoken of as the public side of transportation, although the name is to some extent a misnomer.

Miller's work is considerably the most bulky of the three and accordingly finds room both for a rather elaborate description of legislation and for a good deal of concrete discussion of railroad statistics, services, organization, system grouping and the like. All three books are well and carefully done, and teachers of transportation will benefit considerably by their appearance.

As for criticism, there is scarcely space in a short review to point out the strength or weakness of each volume considered. Different writers have different conceptions of what is important in the railroad field, and choice between the books for classroom use will depend largely upon the teacher's conception of what ought to be taught in beginning work.

No one of the three volumes contains more than a very occasional reference to European experience, and no one discusses at any length the nature and direction of the movement of commodities within the United States. The reviewer has thought for some time that transportation should be treated more as a branch of economic geography, and less as a collection of problems in finance, labor, engineering and the like, but in this the authors apparently do not agree with him. Perhaps some day a textbook writer will take another view.

STUART DAGGERT.

JEROME, HARRY. *Statistical Method.* Pp. xxiv, 395. Price, $4.00. New York: Harper & Brothers, 1924.

Anyone reading Professor Jerome's book is immediately impressed by two qualities which it possesses: the clearness and simplicity with which it is written and the emphasis given to statistics as an aid in the solution of economic problems. Both of these are peculiarly requisite in a book on statistical method, the former because few persons possess the mathematical training necessary to follow the concise and sometimes involved discussions of the more advanced books on the subject and the latter because appropriate material is inadequate for the demand.

The method of presentation adopted is, like the reviewer's text on the same subject, a digression from the customary procedure. Briefly stated, it consists of the early introduction of graphic methods, the proximity of the subject of "unreliability" to that of dispersion, the exhibition of actual applications of index-number principles to a variety of purposes and the emphasis of historical series and so-called "business barometers." These points all involve questions of presentation and pedagogy rather than of statistical method, but are especially important from the standpoint of the reader who desires to apply his learning to concrete problems.

I was gratified to find that two persons independently wrote books on this subject at approximately the same time with general coincidence in judgment as to method of presentation and material to be included. Both have, I think, with considerable accuracy sensed the needs of the average business man and college student. These two classes of persons require a book which demands a minimum knowledge of mathematics and yet is not too elementary.

In view of the recent publication of my own book, I am apt to be either over-critical or over-considerate of this work. Professor Jerome's book, it might be noted, contains a good deal of valuable material carefully classified on the sources of statistical facts, some material on the theory of probability and error, a special chapter on "business cycles and barome-

ters," some laboratory exercises and data as a basis for same. It is unfortunate that a separate chapter on "units" has been omitted, in view of the importance of this subject to the final usefulness of the collected facts. The author has also followed the common procedure of separately describing the various averages and then in the main leaving it to the student to contrast their respective characteristics when a specific problem arises. There is distinct need for a modification of this treatment so as to follow the idea outlined by Yule of appraising the various averages seriatim with respect to certain defined desiderata. Personally I consider that the subject of index numbers is so extensive in its ramifications as to necessarily involve every aspect of statistical method and so appropriately comes at the conclusion of a book of this character. Professor Jerome has apparently almost, but not quite, reached this same conclusion. Some other methods of dealing with seasonal variations might profitably have been introduced. While this book was probably written before the subject attained its present prominence, the link-relative method is somewhat over-emphasized and at least the chapter references should include some references on other methods.

The author is to be congratulated, however, upon the success with which he has followed out certain very valuable ideas in presentation. One is the use of graphic methods for illustration, another is the consistent distinction between sequential and concurrent variations. Still others are the use of practical illustrations drawn from economic and business fields, the relegation of certain aids to statistical work to the appendices, the interesting description of the uses of statistics, the satisfactory treatment of ratios and the ratio chart, and above all the eminently direct and understandable style of his work.

The book contains some exercises and problems, upon which I cannot refrain from commenting. No one but a teacher can appreciate the difficulty of obtaining satisfactory problems for a reader's use. Limitation in time, necessary emphasis upon individual principles and desirability of practical examples all conspire to make this a task which taxes the ingenuity. An exercise is a set of facts upon which a student mechanically performs certain directed operations, usually consuming an inordinate amount of time and the result of which he is able to predict with reasonable certainty before he begins. A problem (in this connection) is a set of facts to which the student applies his discretion and ingenuity and reaches a debatable conclusion. The examples in this volume must be said, to their credit, to be *problems* rather than *exercises*.

ROBERT RIEGEL.

KOHLER, ERIC L., and PETTENGILL, PAUL W. *Principles of Auditing*. Pp. 231, ix, plus 96 pages of facsimile audit reports, audit working papers, schedules and statements. Price, $4.00. Chicago: A. W. Shaw Company.

As stated in the preface, the book is intended as a text on auditing for university students. The authors recognize that it is impractical and in many cases impossible to teach auditing to university students through the use of books of defunct concerns or through occasional audits of going concerns by the students under supervision. Two other methods are open in the eyes of present-day teachers of auditing—"the preparation of audit working papers and reports from narrated hypothetical cases or in a study of working papers already prepared." The latter method is followed in the book under review. Under this method however, as used in the text, the student must obtain all his information for the report and statements from the working papers, including the adjusting entries. Such a procedure does not give the student practice in preparing adjusting entries and other working papers from a given set of conditions. The narrative form of audit problem gives this experience, but it fails to some extent in its purpose by not presenting a properly prepared set of working papers to be used as a guide in organizing the data contained in the narrative. The instructor in auditing, who is presumed to have had practical experience in auditing, should in most cases be able to describe the

auditing procedure and to stimulate the imagination of the student so that he can trace all items in the working papers back to the source and appreciate about how the auditor would obtain them in any given case. The authors have anticipated this difficulty and have met it in a satisfactory manner by showing on the several working papers to a reasonable extent the operations performed by the auditor. In fact some of the most valuable points in auditing procedure are stated in the comments on the face of the numerous working papers.

From the instructor's point of view the authors have made a wise arrangement with the publishers for supplying for class use in loose leaf form other sets of working papers with solutions. These sets relate to different kinds of business and are sufficiently numerous, we are told in the preface, to make it practicable for solutions to be distributed to the students.

The text material reflects the careful and accurate preparation characteristic of the authors. The opening chapter is a very appropriate one on the accounting profession—its development, requirements and ethics. The chapters dealing with the conduct of the audit and the theories underlying the proper presentation of business facts and figures in the statements cover the subjects usually treated in auditing texts. There is something in the method of presentation in the text under review, however, which seems to reveal a closer contact on the part of the authors with teaching problems than is revealed in most of the other auditing texts on the market. The difficulties and questions of the novice seem to be anticipated in the suggestions offered by the authors. The 207 questions on auditing afford ample review material. The 96 pages of facsimile audit reports and working papers should reveal to the student the nature and scope of the auditor's work in analyzing accounts and verifying assets and liabilities.

There are several good books on auditing, but some of them contain too much accounting theory. There are one or two good books emphasizing primarily the auditor's working papers. The book prepared by Messrs. Kohler and Pettengill is a happy combination of the best features of the two types. It treats auditing procedure in a satisfactory manner, assuming, and rightly so, that the student or junior accountant is fairly well grounded in accounting theory, and it covers in its forms the correct use of auditor's working papers.

HIRAM T. SCOVILL.

RIEGEL, ROBERT. *Elements of Business Statistics*. Pp. xx, 549. Price, $4.00. New York: D. Appleton & Company.

This book should be particularly successful in "selling" statistical methods to the business world. Making no claims to originality, it consists in an exceptionally well-documented exposition of elementary statistical procedure, as the latter may be applied to business problems. That business and economic phenomena may differ in important respects from vital or social phenomena and hence in the requirements of statistical treatment or interpretation is made clear. Thus,

> while in biology and anthropology . . . there is often very conclusive evidence of the existence of a really typical condition, . . . in economic and business statistics there is often no reason to assume that there is any truly typical condition. Even if there is, we are frequently interested in the exceptions to the type rather than the type itself (p. 273).

In bringing statistics within the comprehension of persons unaccustomed to thinking in abstract and mathematical terms, the author has at most points achieved a clarity of exposition that will commend his book to non-technical readers in fields other than business. The entire work seems suggestive of "efficiency" and "scientific management." We should expect to find above the author's desk, together with an organization chart of a model factory, a comprehensive graph of the science of statistics, in which each element and principle was concisely and clearly shown in its relationship to every other. For example, Professor Riegel classifies statistical units according to origin, functions and complexity. From the latter viewpoint they are of three kinds, simple, compound and complex. Categorical classifications of this sort may appear unduly rigid, but they serve the less experienced as a convenient routing chart to the subject.

As might be expected, the presentation is graphical to a high degree. Graphs are employed not merely as a means of presenting factual data but as a means of illustrating principles as well. A discussion of graphic methods is introduced immediately following the introductory chapters. In the chapters on "Correlation" and "Ratio of Variation," one may doubt the wisdom of the author's selection of topics: thus a discussion of non-linear relationships is omitted, but the equally difficult subject of partial correlation is included. The chapters on "Index Numbers" seem especially serviceable. The book is excellently indexed with reference to the statistical terminology employed, but is seriously lacking an index of illustrative material. Thus the reader who is unfamiliar with "freight density" must struggle with the concept for a number of pages until he finally reaches a definition—a difficulty that might immediately be overcome were this particular ratio listed in the index.

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